Engineering Library

DEC 30 1926

Printed on Thin Paper for Foreign Circulation

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLII.—No. 3701] LONDON: FRIDAY EVENING, DECEMBER 17, 1926 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 2d.

PUBLIC NOTICES

Assistant Engineer Re- QUIRED by the GOVERNMENT of PALESTINE for the PUBLIC WORKS DEPARTMENT for three years' service, with possible permanency. Salary £E550, rising to £E750 by annual increments of £E25, plus £E50 per annum expatriation allowance and a temporary cost-of-living allowance, at present amounting to 5 per cent. of the minimum salary of the appointment, plus £E37 a year. Free passages. Candidates, single, aged 30 to 40, must be A.M.I.C.E. and preferably have been trained in a Municipal Engineer's office, must have had general experience on works and in office in charge of construction and maintenance of buildings, roads, bridges, water supply and drainage, and the preparation of designs and estimates for such works. Experience on sea walls is desirable.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15066. 4254

Assistant Engineer Re- QUIRED for the RAILWAY DEPARTMENT of NIGERIA for a tour of 12 to 18 months' service, with possible extension. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, must have passed examination to qualify for A.M.I.C.E. or hold equivalent professional qualifications and have had experience in maintenance and construction on a recognised railway in the United Kingdom or a British Colony. A good knowledge of surveying is essential.—Apply at once by letter, stating age and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14790. 4246

Assistant Engineers (7) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, must have passed the examination for A.M.I.C.E. or possess a degree in Civil Engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. They must have had proper technical training and preferably have had not less than two years' subsequent experience on large engineering or municipal works. Candidates possessing other civil engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485. 4188

INDIAN SERVICE OF ENGINEERS.

The Secretary of State for India in Council will in 1927 APPOINT TEN ASSISTANT EXECUTIVE ENGINEERS for this Service, including, if possible, one Burman, who will be appointed to the India recruited branch in Burma. Except for this one appointment every candidate must be a European British subject of non-Asiatic domicile.

Candidates must be not less than 21 years and not more than 24 years of age on 1st August, 1927.

They must either (1) have obtained one of certain recognised University degrees or other distinctions in engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination, or (3) have passed the Associateship in Civil Engineering of the City and Guilds Institute (Imperial College of Science and Technology, South Kensington), or (4) produce the required evidence that they are otherwise eligible under the Regulations. They must in addition have had at least one full year's practical experience of civil engineering under a qualified civil engineer at the time when they appear before the Selection Committee.

Applications from candidates must reach the India Office not later than 1st April, 1927.—Printed forms, together with information regarding the conditions of appointment, may be obtained from the SECRETARY, Services and General Department, India Office, Whitehall, London, S.W. 1.

India Office. 4222

In the Matter of CROFTS (ENGINEERS) LIMITED AND REDUCED

and

In the Matter of THE COMPANIES (CONSOLIDATION) ACT 1908.

Notice is Hereby Given that a PETITION for CONFIRMING the REDUCTION of the CAPITAL of the above Company from £250,000 to £150,000 was on the 18th day of November 1926 presented to the High Court of Justice and is now pending. A list of the persons admitted to have been creditors of the Company on the said 18th day of November 1926 (the date fixed by the Order in this matter dated the 9th day of December 1926) may be inspected at the Offices of the Company at Empire Works, Thornbury, Bradford, Yorkshire, at the Office of Messieurs F. G. and H. E. Smith, Solicitors, of No. 33, Kirkgate, Bradford, aforesaid, or at the Office of J. B. Somerville, Solicitor, at No. 11, New-square, Lincoln's Inn, London, W.C. 2, at any time during usual business hours on payment of the charge of one shilling.

Any person who claims to have been on the last-mentioned day and still to be a creditor of the Company and who is not entered on the said list and claims to be so entered must on or before the 7th day of January 1927 send in his name and address and the particulars of his claim and the name and address of his Solicitor (if any) to the undersigned the London Agent for the Solicitors to the Company or in default thereof he will be precluded from objecting to the proposed reduction of capital.

Dated this 9th day of December 1926.

J. B. SOMERVILLE,
11, New-square, Lincoln's Inn, London, W.C. 2.
Agent for F. G. and H. E. Smith, of No. 33, Kirkgate, Bradford, Yorkshire,
Solicitors for the said Company.. 4210

Crystal Palace School of Practical Engineering.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 3685

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

Reinforced Concrete Coal and Ore Silos (With a Two-Page Supplement). THE ENGINEER, 17 - 12 - 26.

London Bridges. THE ENGINEER, 17 - 12 - 26.

Models for Demonstrating Electrical Principles No. XIX. THE ENGINEER, 17 - 12 - 26.

Air-craft Development in France. THE ENGINEER, 17 - 12 - 26.

Electricity Commissioners' Report. THE ENGINEER, 17 - 12 - 26.

Marine Oil-Engine Trials Committee. THE ENGINEER, 17 - 12 - 26.

Surface-hardened Gear Teeth. THE ENGINEER, 17 - 12 - 26.

Kristofer Polhem. (J. G. A. RHODIN.) THE ENGINEER, 17 - 12 - 26.

An Automatic Precision Lathe. THE ENGINEER, 17 - 12 - 26.

PUBLIC NOTICES

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.SC. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
3998 Newcastle-upon-Tyne.

State Electricity Commission OF VICTORIA, AUSTRALIA.

TENDERS are hereby INVITED for the MANUFACTURE, SUPPLY and DELIVERY for the Yallourn Brown Coal Works, Victoria, Australia, of ONE (1) only OVERBURDEN DREDGER in accordance with Specification No. 27/8.

Copies of Tender form, specification and drawings, &c., will be available upon application to:—

THE AGENT-GENERAL FOR VICTORIA,
Victoria House, Melbourne-place,
Strand, London, England;
and Herr J. KLITZING,
Bergwerksdirektor, Grube Marga, Bei Senftenberg, Germany.

PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is to be lodged with Tender.

Tenders, on prescribed form, in duplicate, properly endorsed and addressed, must be delivered at the office of the Agent-General not later than 17th January, 1927.

The Commission does not bind itself to accept the lowest or any Tender. 4256

PUBLIC NOTICES

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Tuesday, 11th January, 1927, TENDERS for the SUPPLY of:—

1. STEEL SLEEPER KEYS.
2. CRUDE OIL ENGINE GENERATOR SETS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of £1 each for No. 1 and 10s. each for No. 2 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty France,
Westminster, S.W. 1.
13th December, 1926. 4231

PUBLIC HEALTH ACT, 1875.

Rural District of Faversham, KENT.
CONTRACT NO. 1.

The Rural District Council of Faversham, acting as the Sanitary Authority for the said district, are prepared to receive TENDERS for WORKS of SEWERAGE and SEWAGE DISPOSAL in the Parishes of Teynham and Lynsted. The works will comprise 4147 Yards of 7in. diameter Stoneware and 149 Yards of Cast Iron Sewers, 1156 Yards of 6in. diameter Stoneware and 49 Yards of Cast Iron Sewers, together with all Manholes, Ventilation Columns, &c., Sedimentation Tanks, Filter Beds, and all works incidental thereto.

Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Monday, the 20th of December, until Friday, the 31st of December, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of Three Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.

The successful tenderer will be required to execute a contract bond, the draft of which is incorporated with the specification.

Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for Teynham and Lynsted." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.

Each Tender must be signed in the handwriting of the tenderer or his authorised agent.

The Council does not bind itself to accept the lowest or any Tender.

Tenders must reach the undersigned by 9 a.m. on Monday, the 24th of January, 1927.

Given under my hand the 14th day of December, 1926.

GUY TASSELL,
Clerk to the Faversham R.D.C.
19, West-street, Faversham, Kent. 4203

PUBLIC NOTICES

Sudan Government Railways REQUIRE the SERVICES of TWO DISTRICT ENGINEERS. Age 26 to 32, single. Candidates should have had practical training on a British railway and possess an A.M.I.C.E. degree or equivalent. Starting rate of pay £E480 to £E540 per annum, according to age and qualifications (£E1 equals £1 0s. 6d.). Progressive and pensionable posts if retained. Strict medical examination. Free first-class passage. Liberal leave on full pay with assisted passages.—Apply by letter to ADVISORY ENGINEER, Sudan Government London Office, Wellington House, Buckingham-gate, S.W. 1, marking envelope "District Engineer." 4236

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a Thoroughly Practical WORKS MANAGER for a Tank and Boiler Works in East London; must thoroughly understand his job, be a good organiser, capable of handling workpeople, and have a thorough knowledge of piecework prices. Good remuneration and bonus to the right man.—Address, giving full particulars of age, experience, and salary required, 4241, The Engineer Office. 4241 A

WANTED, JUNIOR TRAVELLER by Large Steel Works manufacturing all classes Forgings, Castings, Shipbuilding and Railway Material, Alloy Steels, &c. Exceptional opportunity for suitable applicant whose qualifications must be thoroughly first class. Mechanical training essential.

Apply in strict confidence, giving age, training and travelling experience, to Box 404, W. H. Smith and Son, Strand House, W.C. 2. P2577 A

WANTED, SALESMAN, with Connection Amongst Motor Car Manufacturers and Wagon Builders, to Sell Press Work. Must be an experienced engineer.—Address, 4212, The Engineer Office. 4212 A

WANTED, Young Energetic ENGINEER for Estimating Department, accustomed to all types of Conveying and Elevating Plant and Structural Work. Good knowledge of Plating Shop, Machine Shop and Foundry Practice, and with Drawing-office experience for checking drawings.—Address, giving full particulars of suitability for such position, 4217, The Engineer Office. 4217 A

ASSISTANT ENGINEERS WANTED, with Civil and mechanical training. Age 25 to 30. Must have had good practical experience in construction of Oil Depots or similar work. Salary £250-£300 per annum.—Applicants should state fully experience and send copies of references to Box Z.Y. 293, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 4257 A

ENGINEER SALESMAN WANTED; Young Mechanic with good general education, also technical and practical engineering experience. Knowledge of Compressed Air and its uses an advantage.—Address, giving full particulars as to age, qualifications, experience, and salary expected, 4252, The Engineer Office. 4252 A

MACHINE TOOL DESIGNER.—An OPENING occurs for a First-class MACHINE TOOL DESIGNER of good education and broad views, who is capable of earning £1000 a year.

Applications will be treated in strict confidence.

Address, P2540, The Engineer Office. P2540 A

MECHANICAL ENGINEER, Young Man of Good education and address, WANTED in a Printing House. Opportunity for one with real initiative and ability to qualify for ultimate supervision and control of a large modern plant.—Address, stating fullest particulars of qualifications, degrees (if any), and experience, both practical and technical, 4242, The Engineer Office. 4242 A

PRODUCTION ENGINEER REQUIRED, to Take Charge under Works Manager of Planning, Processing, Rate Fixing, &c., for General Engineering Works in Lancashire. Previous experience in Medium and Heavy Engineering essential.—Address, stating age, experience, and salary required, 4247, The Engineer Office. 4247 A

PRODUCTION MANAGER REQUIRED by Firm of General Engineers. Must have extensive experience of modern practice in ironfoundry, machine and Fitting Shops and possess good organising ability.—Write, giving full particulars of qualifications, salary required, &c., NEW ALLOYS and ONIONS, Ltd., Great Western Works, Birmingham. 4235 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Page 2.
PARTNERSHIPS, Page 2.
AGENCIES, Page 2.
MACHINERY, &c., WANTED, Page 2.
AUCTIONS, Page 80.
FOR SALE, Pages 2, 3 and 80.
PATENTS, Page 2.
MISCELLANEOUS, Page 2.
BUSINESSES and PREMISES (For Sale, etc.), Page 80.
WORK WANTED, Page 4.

For Advertisement Rates see Page 665, Col. 1.

INDEX TO ADVERTISEMENTS Page 79.

SITUATIONS OPEN (continued)

RATE FIXER.—WANTED for District near London, first-class MAN, accustomed fixing times for machining, fitting, erecting general heavy engineering work.—Write, stating experience, age, salary required. Box 436, Sells Advertising Offices, Fleet-street, E.C. 4. 4228 A

ROADMASTER or CIVIL ENGINEER. Just graduated, WANTED for South America, to look after 80 kilometres of track.—Write, Box C. B., 95, Bishopsgate, E.C. 2. 4230 A

YOUNG ENGINEER, Education Public School or equivalent, sound general engineering training, for Sales Department of Engineering Business in India. Salary to commence about Rs. 500 month.—Write, giving fullest particulars education and training, to Box 691, Leathwait and Simmons, 34, Throgmorton-street, E.C. 2. P2553 A

YOUNG MAN, with Sound Technical Training for D.C. and A.C. Motor Electrical Design. State age, training, experience, and salary expected.—Address, 4246, The Engineer Office. 4246 A

WORKS CHEMIST.—A Modern GENERAL ENGINEERING FIRM REQUIRE the SERVICES of a capable and well-trained CHEMIST and METALLURGIST. Must be capable of taking entire charge of laboratories, including chemical and physical tests. Experience on Ferrous, Non-ferrous and Alloy Steel Materials essential, and some knowledge of the Manufacture of Perlit Irons an advantage. Applications, which will be treated in confidence, must state full details of experience and qualifications, age, and salary required.—Address, 4167, The Engineer Office. 4167 A

WANTED AT ONCE, ONE CHIEF DRAUGHTSMAN and THREE SENIOR DRAUGHTSMEN, with experience in design and lay-out of Cement Plants and Machinery. State experience, qualifications, and salary required.—Address, 4211, The Engineer Office. 4211 A

WANTED, DRAUGHTSMAN, Experienced in Pumping Machinery, with special knowledge of Turbine and Centrifugal Pumps. State salary required and experience, with names of previous employers (which will be treated in strict confidence).—Address, 3986, The Engineer Office. 3986 A

CHIEF DRAUGHTSMAN.—REQUIRED by Large Firm of Constructional Engineers in Manchester, a thoroughly competent MAN, to Take Charge of Drawing-office. Must be good designer, keen and energetic.—Address, stating age, full details of experience and salary required, 4243, The Engineer Office. 4243 A

DRAUGHTSMAN, Mechanical, Experienced, WANTED, 25 to 35, unmarried. Must have had experience in designing Structural Steel Work and Machinery, not tools.—Write, stating age, full experience, salary, to "D. W.," c/o Street's, 6, Gracechurch-street, E.C. 3. 4224 A

DRAUGHTSMAN REQUIRED in London, with sound knowledge Steam Boiler Installations and Accessories. One preferred experienced in design of Superheaters.—Address, 4202, The Engineer Office. 4202 A

DRAUGHTSMAN, with All-round Electrical Experience, especially of modern A.C. and D.C. development up to 250 H.P. Please state experience, age, salary expected, and when free.—Address, 4240, The Engineer Office. 4240 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine Design and Detail Work. State age, salary, experience, and when able to commence.—Address, 4200, The Engineer Office. 4200 A

ENGINEER DRAUGHTSMAN, Experienced in the Theory and Practice of Ventilation, with a comprehensive knowledge of Building Construction and Decoration.—Address, 4206, The Engineer Office. 4206 A

EXPERIENCED DRAUGHTSMAN REQUIRED by Midland Firm, to Take Charge of Section of Drawing-office dealing with Sand Blast, Sand Handling and Preparing Plants. Must be able to get out own estimate figures and follow up jobs to completion. Only experienced men, giving full particulars of experience and salary required, need apply.—Address, 4245, The Engineer Office. 4245 A

SENIOR DRAUGHTSMAN WANTED for Engineering Works in Lancashire, thoroughly experienced in the design and lay-out of Large Condensing Plants for Electricity Undertakings. Only experienced men need apply, stating age, experience, and salary required.—Address, 4204, The Engineer Office. 4204 A

SENIOR DRAUGHTSMAN WANTED; up-to-date experience in design of Road Rollers and Light Haulage Engines an essential qualification. Applicant must have occupied responsible position and be capable of exercising efficient control over drawing-office. Give details of experience, stating age, salary required, and when at liberty.—Address, P2578, The Engineer Office. P2578 A

STRUCTURAL STEEL WORK.—WANTED, TWO first-class JUNIOR DRAUGHTSMEN, with good experience of Steel-frame Building Work. Able to detail for fabrication from steel plans on own responsibility. Must also be quite competent to take dimensions at site. State salary required.—Applications only by letter to CHIEF DRAUGHTSMAN, Messrs. Smith Walker, Ltd., 33, Tothill-street, S.W. 1. P2576 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE SEVERAL DRAUGHTSMEN with Blast-furnace and Steel Works experience.—Apply in writing to CHIEF ENGINEER, c/o above. 4238 A

WANTED for a London Firm of Engineers, a capable PLATER FOREMAN, with experience of Cylindrical and Constructional Steel Work.—Address, stating age, experience, and salary, 4207, The Engineer Office. 4207 A

LOCOMOTIVE RUNNING SHED FOREMAN, about 28 to 40, WANTED. Must have had considerable foreman's experience, repair, upkeep locos. Must speak some Spanish.—Write, sending full particulars, "B. S.," c/o Street's, 6, Gracechurch-street, E.C. 3. 4223 A

SITUATIONS WANTED

ADVERTISER, Age 41, DESIRES RE-ENGAGEMENT as Foundry Manager. Has had considerable experience in the manufacture of general engineering castings, special and vertically cast pipes. Last position 7½ years.—Address, P2542, The Engineer Office. P2542 B

CONTRACTOR'S AGENT of Proved Ability DISENGAGED. Many years' experience in civil engineering and reinforced concrete contracts, successful estimator, organiser and supervisor. Highest references.—Address, P2508, The Engineer Office. P2508 B

ENGINEER (37), Shortly Disengaged, DESIRES POSITION as Works Manager or similar capacity. Automobile and general, wide experience.—Address, P2565, The Engineer Office. P2565 B

LOCO. and CARE. ENGINEER, 10 Years' Experience Indian railways, both loco. and traffic, 2½ years light railways in France, four years railway managing agents, experience including sale railway materials, power and rolling stock, good organiser and administrator, very keen business side railway work, REQUIRES POST in connection with railways. Excellent references, public school. Papers sent on request.—Address, P2558, The Engineer Office. P2558 B

SITUATIONS WANTED (continued)

POSITION WANTED, either Metallurgical Chemist, Coke Oven Manager or Assistant: 12 years' general laboratory work, 5 years' coke oven and tar plants manager. Highest references.—Address, P2579, The Engineer Office. P2579 B

DRAUGHTSMAN (London District) SEEKS SITUATION: 20 years' good all-round engineering experience.—Address, P2474, The Engineer Office. P2474 B

ENGINEER-DRAUGHTSMAN (Mech.), 26, Seeks POST of TRUST; 11 years' experience printing and general shops. D.O. and office.—A., 40, St. James-road, Sutton. P2581 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 75 years.

AN ENGINEERING COMPANY in Cheshire, with LARGE MODERN WORKS thoroughly equipped on up-to-date lines, would LIKE to CONNECT with an ENGINEER with some capital at his disposal and preferable specialities to develop.—Address, 4190, The Engineer Office. 4190 C

YOUNG MECHANICAL ENGINEER, with First-class training, SEEKS POSITION with prospects in engineering or other business where his experience would be of value. Capital available £2000-£3000.—Apply to FLEMING and WILSON, C.A., 175, Hope-street, Glasgow. 4258 C

EDUCATIONAL

CIVIL ENGINEERING
CORRESPONDENCE COLLEGE.

CORRESPONDENCE TUITION for Institution of Civil Engineers Examinations.
New Prospectus, based on amended Institution Examination Syllabus, on application to
THE SECRETARY,
22, Noel-road, Edgbaston, Birmingham.
P2408 B

COACHING for INST. C.E. EXAMINATION. Personal or by correspondence.—To G. W. M. BOYCOTT, Assoc. M. Inst. C.E., 1, Orchard Drive, Blackheath, S.E. 3. 4150 E

CORRESPONDENCE COURSES for Inst. Civil Engineers, Inst. Mech. E., London Univ., and ALL ENGINEERING EXAMINATIONS, personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Eng., London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., &c. Excellent results at all Exams., comprising hundreds of successes. Courses may commence at any time.—Apply to Mr. TREVOR W. PHILLIPS, B.Sc., (Hons.), A.M.I.C.E., &c., 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN-STREET, LIVERPOOL. Tel. No. Bank 1118.—London Office: 45, Chancery-lane, W.C. 2. Ex. B

DRAUGHTSMANSHIP.—A Qualified ENGINEER, with over 25 years' highly successful experience as a teacher of draughtsmanship, offers postal tuition by means of his simplified home-study Course. The instruction is specially devised to suit the needs of individual students, and COACHING for PROFESSIONAL EXAMINATIONS is a speciality. Low fees. Booklet E free on request.—Mr. PERCY PITMAN, M.I. Mech. E., 25, Victoria-street, London, S.W. 1 (Established 1894). Ex.

ENGINEERING PUPIL.—CIVIL ENGINEER, Holding important public appointment, has a VACANCY for a well-educated YOUNG GENTLEMAN as a PREMIUM PUPIL.—Address, 4214, The Engineer Office. 4214 E

AGENCIES

CRUCIBLES.—AGENCY REQUIRED by Well-known Firm of Foundry Specialists for the Sale of Plumbago Crucibles of highest quality for ferrous and non-ferrous metals. Advertisers have large connection in the trade and a well-organised staff of technical and practical travellers.—Address, 4251, The Engineer Office. 4251 D

MANUFACTURERS and CONCESSIONNAIRES of one of the most important and valuable Industrial Accessories of recent years want to ARRANGE a DISTRICT DISTRIBUTION covering almost every phase of industrial activity. Engineers and engineers' agents with facilities for designing and carrying out installations preferred. Must be first-class established firm giving highest references.—Address, P2573, The Engineer Office. P2573 D

STEAM FITTINGS AND VALVES.—Well equipped MAKERS of highest grades REQUIRE BUYING AGENTS in three or four centres, excluding Lancashire and Yorkshire.—Address, P2582, The Engineer Office. P2582 D

MISCELLANEOUS

THE GAS PUMP for Fen Drainage, Irrigation and all Low-lift Heavy Volume Work is unsurpassed. It burns cheap and often waste fuel or oil, requires no lubrication and cannot be damaged through neglect on that account. The Punjab alone can absorb a large output. Manufacturers are invited to communicate with Mentese of simplified and improved type approved by accepted experts as to design.—Address, 4205, The Engineer Office. 4205 I

PATENTS

KING'S PATENT AGENCY, Ltd. (Director, B. T. KING, C.I.M.E., Registered Patent Agent, G.B., U.S., and Canada). Inventions advice handbook and consultations free. — 146a, Queen Victoria-street, London, E.C. 4. 40 years' refs. 'Phone: Central 682. 3616 H

OPPORTUNITY TO ACQUIRE VALUABLE PATENTS.—ENGINEER, having fully developed and patented in important countries efficient ELECTRIC GAUGE to indicate contents of tanks—automobiles, bulk storage, ships, aircraft, reservoirs, &c.—will NEGOTIATE MANUFACTURING RIGHTS or SELL OUTRIGHT. Working models seen by appointment.—Address, 4242, The Engineer Office. 4242 E

THE OWNERS of BRITISH PATENTS Nos. 193,627 and 196,664, for "Improvements in Sizing and Quenching Annular Metal Articles, such as Cups and Cones for Roller Bearings," are DESIROUS of ENTERING into NEGOTIATIONS with one or more firms in Gt. Britain for the purpose of EXPLOITING the above invention, either by SALE of the PATENTS or by the GRANT of a LICENCE or LICENCES to manufacture on royalty.—Enquiries should be addressed to Messrs. ABEL and IMRAY, 30, Southampton-buildings, London, W.C. 2. 4227 H

PATENTS

THE OWNER of BRITISH PATENT No. 209,095, relating to "Improvements in and relating to Internal Combustion Engines," is DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES thereunder on reasonable terms.—For particulars address, A. S. CACHEMAILLE, 2, Norfolk-street, Strand, London, W.C. 2. 4255 H

THE PROPRIETOR of BRITISH PATENT No. 1262/12, dated January 16, 1912, relating to "Machine for Making Hairpins," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4157 H

THE PROPRIETOR of BRITISH PATENTS Nos. 135,362 and 139,551, both dated January 10, 1919, relating to "Improvements in Machine for Forming Hairpins or Similar Articles," and "Improvements in Machine for Counting and Arranging Hairpins or like Forked Articles," respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCES or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical working in Great Britain.—All inquiries to B. SINGER, Steger Building, Chicago, Illinois. 4158 H

PATENTS.—"AN IMPROVED PROCESS FOR THE MANUFACTURE OF CONVERTER BOTTOMS, FURNACE HEARTHS AND THE LIKE FOR METALLURGICAL PURPOSES."
THE PROPRIETORS of Mr. A. BOSSHARD'S BRITISH PATENT No. 108412 are DESIROUS of LICENSING it to British manufacturers on reasonable terms to ensure its MANUFACTURE and DEVELOPMENT in Great Britain, or of selling the patent outright.—For full information address enquiries to W. P. THOMPSON and CO., Chartered Patent Agents, 12, Church-street, Liverpool. P2580 H

THE PROPRIETOR of BRITISH PATENT No. 209,373, dated December 11, 1922, relating to "Improvements in Ventilator," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Woolworth Bldg., New York City, N.Y., U.S.A. 4156 H

THE PROPRIETOR of BRITISH PATENTS Nos. 137,121 and 141,137, both dated January 9, 1919, relating to "Improvements in Apparatus for Measuring Difference Between Fluid Pressures and Applicable to Fluid Velocity Meters and the like," and "Improvements in Means for Controlling Combustion in Steam Generator and like Furnaces," respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical workings in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4218 H

THE PROPRIETOR of BRITISH PATENT No. 129,572, dated January 20, 1919, relating to "Improvements in Automatic Sprinkler," is DESIROUS of ENTERING into ARRANGEMENT by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Woolworth Bldg., New York City, N.Y., U.S.A. 4219 H

THE PROPRIETOR of BRITISH PATENT No. 214,705, dated January 22, 1923, relating to "Improvements in the Regulation of Combustion," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4221 H

THE PROPRIETOR of BRITISH PATENT No. 178,507, dated January 4, 1921, relating to "Improvements in Electric Motor Controllers," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4220 H

BRITISH PATENT No. 172,645, "Direct and Four-fold Action Steam Pump without Valve Chests or Internal or External Mechanism with Balanced Steam-saving Valve Gear." Already in use in Germany, Austria, Hungary, and Italy. PURCHASERS or LICENSEES WANTED for Gt. Britain.—Enquiries should be addressed to ABEL and IMRAY, 30, Southampton-buildings, London, W.C. 2. 4225 H

THE PROPRIETOR of the PATENT No. 187,521, for "Silent Chains," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C. 2. 4226 H

TO MOTOR MANUFACTURERS.—The PROPRIETOR of PATENT No. 199,752 is DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES to manufacturers on royalty or otherwise or to TREAT for the SALE of the PATENT outright.—Particulars will be furnished on application by A. M. and WM. CLARK, 53 and 54, Chancery-lane, London, W.C. 2. 4229 H

MACHINERY, &c., WANTED

WANTED, a Good Second-hand WATER-TUBE BOILER with chain grate preferred, for not less than a working pressure of 150 lb. and for 400 H.P. State lowest price, age, and where it can be inspected.—H. J. H. KING and CO., Ltd., Engineers, Nailsworth. 4244 F

WANTED, COPPER-LINED TANK with Deep Steam Jacket with Stirrer, about 40-60 lb. steam pressure, mixing capacity 400-600 galls.—Apply, ENGLISH GRAINS CO., Ltd., Burton-on-Trent. 4250 F

WANTED, Good Second-hand HORIZONTAL STEAM ENGINE with cylinder 20in. bore by 36in. stroke, fly-wheel on left-hand side when standing at cylinder end and looking towards crank. Must be by good maker and cheap.—Address, 4239, The Engineer Office. 4239 F

WANTED, ONE 28ft. by 7ft. LANCASHIRE STEAM BOILER in good condition, insurable 125 lb. per sq. inch w.p. or upwards, with or without fittings.—Address, P2575, The Engineer Office. P2575 F

WANTED, Second-hand 20-50 K.V.A. Three-phase, 50-150-cycle ALTERNATOR, 0-440 volts at 150 cycles. Complete motor alternator set, if possible.—Address, 4201, The Engineer Office. 4201 F

WANTED, TWO 5-Ton LOCO. STEAM CRANES and ONE 5-Ton STEAM DERRICK CRANE. Only cranes of recent make and in first-class condition will be considered.—Full particulars, place of inspection, and lowest possible prices to JOSEPH PUGSLEY and SONS, Ltd., Lawrence-hill, Bristol. 4215 F

WANTED, Up-to-date LEAD EXTRUDING PRESS, four column type, with container to hold 2 to 3 cwt.—JOSEPH PUGSLEY and SONS, Ltd., Lawrence-hill, Bristol. 4216 F

EGG-ENDED BOILER SHELL WANTED, About 5ft. by 28ft., for storage purposes. State price and full particulars.—Address, 4213, The Engineer Office. 4213 F

FOR SALE

STEEL RAILS.
All Sections.
(British Steel and Manufacture).
POINTS & CROSSINGS,
CHAIRS, etc.
EDWARD SISTERSON, LTD.
St. Nicholas Chambers,
NEWCASTLE-ON-TYNE.

ENQUIRIES INVITED
FOR
LARGE STOCK OF MACHINERY AND PLANT
Available for Immediate Disposal.
Overseas orders packed and delivered, F.O.B. Glasgow Docks.
JOHN McILWAINE,
Engineer, 816, Paterhill-road, Springburn, Glasgow.

BOILERS FOR SALE:—
Seven, 30ft. by 9ft., 160 lb. pressure.
Two, 30ft. by 7ft. 6in., 120 lb. pressure.
Two, 22ft. 6in. by 7ft., 100 lb. pressure.
Two Semi-portable, 15ft. by 8ft. 6in., by 100 lb. pressure.
One Semi-portable and Engine, 9ft. by 30in., 80 lb. pressure.
WM. KAYLEY, Queen-street, Ardwick, Manchester. 3818 G

DELIVERY FROM STOCK, Subject Being Unsold.—
New 30ft. by 8ft. 6in. LANCASHIRE BOILER, 160 lb. W.P.
New 30ft. by 7ft. 6in. DITTO, 180 lb. W.P.
New 30ft. by 9ft. 6in. CYLINDRICAL TANKS or RECEIVERS, 60 lb. W.P.
New 11ft. by 5ft. DITTO, 90 lb. W.P.
New 10ft. by 4ft. 6in. AIR RECEIVER, 100 lb. W.P.
S.H. 20ft. by 7ft. 6in. LANCASHIRE BOILER, 100 lb. W.P.
S.H. 30ft. by 8ft. DITTO, suitable tank.
S.H. 30ft. by 7ft. CORNISH BOILER, suitable tank.
S.H. 18ft. by 6ft. 6in. LANCASHIRE BOILER, suitable tank.
H. and T. DANKS (NETHERTON), Ltd., Netherton, Dudley. 4037 G

FOR IMMEDIATE SALE, ONE First-class Second Hand 6ft. VERTICAL BORING and TURNING MILL, by Richards; maximum swing 6ft. 3in., table 5ft. 4in. diameter, fitted with four-chuck jaws, two heads, cone driven; in excellent order throughout. Low price.—JOHN H. RIDDEL, Ltd., 40, St. Enoch-square, Glasgow. 4066 G

FOR SALE.

5-TON DOUBLE PURCHASE STEAM-DRIVEN WINCH, by Sheppard, of Bridgend, steam cyls. 8½in. dia., 10in. stroke, 36in. dia. drum by 24in. wide.
45in. dia. STEAM-DRIVEN HYDRO-EXTRACTORS, makers, Potts, Cheadle, suspended type, with steel perforated cage or basket.
Modern 13in. Centre LATHE, by Milwaukee, with straight "V" bed, 12ft. long, S.A., S.S. and S.C., gear-box change, &c.
6in. CENTRIFUGAL PUMP, by Gwynnes, direct electric motor driven, for 440 volts D.C., complete.
4in. DITTO, for 440 volts, all complete.
MASSIVE SET of HORIZONTAL BELT-DRIVEN GEARED TWO-THROW PUMPS, by Lee, Hewl; pistons 6in. by 12in. stroke, 20,000 g.p.h. at 75 strokes per minute.
LARGE HORIZONTAL SET BELT-DRIVEN GEARED THREE-THROW RAM PUMPS, by Campbells; rams 8in. by 12in. stroke, cap. 12,000 g.p.h. to 600ft. serlee.
VERTICAL STEAM-DRIVEN DOUBLE RAM PUMPS, all cast iron valves, cyls. 8in. by 10in., rams 6in. by 8in., C.I., 7000 g.p.h.; also DITTO, cyls. 6in. by 8in., all cast iron valves and rams, 4in. by 6in. stroke, cap. 3000 g.p.h.
VERTICAL BELT-DRIVEN DOUBLE RAM PUMPS, all cast iron fitted, rams 6in. dia. by 6in. stroke; and DITTO, 4in. by 6in. stroke.
200 K.W. GENERATOR, by Crompton, shunt wound, interpole, 220 volts D.C., 910 amps., cont. rating, speed 1500 r.p.m.
TWO 120 K.W. GENERATORS, by Electrometers, shunt wound, interpole, cont. rating, 230 volts D.C., 448 amps., 1200 revs.
GOOD RACK-DRIVEN PLANING MACHINE, table 7ft. 6in. overall by 2ft. 9½in. wide, running on "V" bed, admit between pillars 5ft. 6in., thoroughly overhauled.
FURTHER PARTICULARS ON APPLICATION.
SEND FOR LISTS.
STANLEY ENGINEERING CO., Bath. Ex.

FORGING MACHINES, Ex Stock.—
"Ajax-Eumuco," S.M.1, material 1 3-16in. dia.
"Ajax-Eumuco," S.M.3, material 2in. dia.
"Ajax-Eumuco," S.M.5, material 2 3-8in. dia.
"Ajax-Eumuco," S.M.7, material 3½in. dia.
S. INGRAMS and CO., 283, Finsbury Pve. House, London. 4233 G

For continuation of For Sale Advertisements see page 3.

CONSTABLE & COMPANY LTD.,
Publishers of
"THE ENGINEER LIBRARY."

THE GYROSCOPIC COMPASS.
By T. W. CHALMERS, B.Sc. A.M.I. Mech. E.
Demy 8vo. Illustrated. 11/ net

PAPER-MAKING AND ITS MACHINERY.
By T. W. CHALMERS, B.Sc., A.M.I. Mech. E.
Imperial 8vo. Illustrated. 36/ net.
Nature.—"We are glad to recommend it to those associated with the paper industry."

A NEW VOLUME.
DEVELOPMENTS IN POWER STATION DESIGN.
By H. AUSTIN.
Imp. 8vo. Illustrated. 21s. 6d.

WHAT INDUSTRY OWES TO CHEMICAL SCIENCE.
By RICHARD B. PILCHER and FRANK BUTLER JONES, B.A. With an introduction by SIR GEORGE BEILBY, LL.D., F.R.S. Crown 8vo. 4s. net.

CONSTABLE & CO., LTD.,
10-12, ORANGE STREET, W.C. 2.

A Seven-Day Journal

The Gas Industry and Foreign Coal.

SOME interesting information regarding the effect of the coal stoppage on the working of the gas industry was given on Tuesday, December 14th, by Mr. D. M. Watson, president of the National Gas Council, speaking at a luncheon held in London. Mr. Watson said that at the beginning of the stoppage the gas companies had in most cases stocks of fuel in hand sufficient to last about three months. The industry had continued to meet its obligations with coal obtained from whatever source was open to it. Even to-day, with the stoppage nominally over, many companies were experiencing difficulty in obtaining supplies. His own company, the Gas Light and Coke Company, had so far received from its usual coalfield only seven cargoes of coal, a supply sufficient for only two days' needs. Without the foreign coal which had been purchased in hundreds of thousands of tons the gas industry could not have given supplies during the stoppage and would have been unable to continue operations at the present moment and for the next two months. The coal now coming into the country was purchased at the end of August and in September, when no one could say when the stoppage would end. His own company had had to buy 1,600,000 tons of foreign coal at an extra price of £2,400,000. Allowing £500,000 for the sale of coke, there remained a debit of £1,900,000, towards which the extra income from the increased price of gas would contribute only £370,000. In spite of the fact that the industry had to pay 100 to 150 per cent. more for its coal, it had raised the cost of gas to the consumer by only 20 per cent. His own company would, he said, reduce the price of gas as soon as possible, but it could not do so before it had paid for the foreign coal which it had had to buy.

The Late Sir William Tilden.

PURE and applied chemistry has this week suffered a great loss by the death, which occurred on Saturday, December 11th, of Sir William Augustus Tilden. Sir William was born in London eighty-four years ago. He began his chemical studies with the Pharmaceutical Society and at the Royal College of Chemistry. In 1864 he was appointed demonstrator in chemistry to the Pharmaceutical Society, a post which he held until, in 1872, he became science master at Clifton College. In 1880 he passed from Clifton to Birmingham as Professor of Chemistry and Metallurgy at Mason College, an institution which later provided the nucleus about which Birmingham University grew into its present form. In 1894 he succeeded Sir Edward Thorpe as Professor of Chemistry at the Royal College of Science, a post which he continued to hold until 1909, when he retired as Emeritus Professor of the Imperial College of Science and Technology. He was president of the Institute of Chemistry in 1891–94 and of the Chemical Society in 1903–5, and was knighted in 1909. As a scientific investigator he achieved his reputation principally by his studies of the specific heats of metals and their relationship to their atomic weights and by his investigations into the polymerisation of turpentine. His researches in the second-named field definitely established the theoretical possibility of the synthetic manufacture of rubber. In 1908 the Royal Society awarded him the Davy Medal for the Bakerian lecture and other contributions to the study of metallurgical chemistry. He was the author of many chemical works, several of them of a historical nature.

The Stoke Railway Works.

IT is reported that the London, Midland and Scottish Railway Company intends to close its locomotive, carriage and wagon works at Stoke-on-Trent early in 1927. These works, formerly belonging to the North Staffordshire Railway, employ in normal times about 760 men. It is intimated that such of the staff of the Stoke works as may be required will be transferred to the Crewe and Derby works and that the apprentices will be found employment elsewhere in order that they may be enabled to finish their apprenticeships. A certain number of men over sixty years of age will be retired.

Petters, Limited.

WE are advised by Petters Ltd., of Westland Works, Yeovil, that arrangements have been concluded, as from December 8th, to acquire from Vickers Ltd. the whole of that firm's interest, including the holding of £145,000 first mortgage debentures, in the Ipswich firm of Vickers-Petters, Ltd. We understand that it has been felt for some time that the joint ownership of the firm was disadvantageous, and negotiations were instituted by Petters Ltd. with a view to acquiring the sole ownership. As soon as the necessary formalities have been completed the name of the Ipswich company will be changed to Petters (Ipswich), Ltd. The development of the larger sizes of Petter oil engines was transferred from Yeovil to Ipswich in 1919, and this work will be continued on engines for both industrial and marine use. One of the latest types of engine produced by the firm of Vickers-Petters, Ltd., was described in THE ENGINEER of October 15th. It was a 600 brake horse-power, six-cylinder, 270 revolutions per minute oil engine of the low compression type, one of two units which the firm has recently completed for the twin-screw motor tug Southland, which has been built by the Dublin Dockyard Company (Vickers-Ireland, Ltd.) for the Bluff Harbour Board of New Zealand. These engines are the largest units which have yet been built at Ipswich, but a new design of engine for even higher powers is, we understand, under consideration, and some trials have already been carried out with an experimental unit.

The World's Largest Motor Liner.

AT eleven o'clock on Monday morning, December 13th, there was successfully launched at the Ansaldo Shipbuilding Yard, Sestri-Ponente, near Genoa, the new motor liner Augustus, for the Navigazione Generale Italiana, which, when completed, will be the largest motor liner in the world. She has an overall length of about 710ft. with a beam of over 82ft. and a gross measurement of approximately 32,000 tons. The Augustus will be propelled by four M.A.N. double-acting two-stroke cycle engines, which are designed to give the vessel an average speed of over 20 knots and a maximum speed of 21¾ knots. The engines have been built in Italy by the Cantiere Officine Savoia, of Cornigliano Ligure, near Genoa, under licence from the M.A.N. Company, which has supplied certain component parts. They comprise four main units, each designed for a continuous rating of 6250 brake horse-power at a speed of 120 revolutions per minute. Each unit has six cylinders with a diameter of 700 mm. and a stroke of 1200 mm. The full normal engine power of the ship is 25,000 shaft horse-power, but the machinery is designed to develop 28,000 shaft horse-power continuously over a period of forty-eight hours. The auxiliary electric generator sets and scavenge blowers are placed in a separate engine-room and aggregate some 4750 horse-power. The trials of the Augustus will prove of particular interest, for the vessel has a hull similar to her sister steam turbine-driven liner Roma, which will shortly be placed on her owner's service between Italy and South America.

Transatlantic Wireless Telegraphy.

SUNDAY, December 12th, was the twenty-fifth anniversary of Mr. Marconi's historic achievement in transmitting and receiving wireless signals across the Atlantic for the first time. On December 11th, 1901, Mr. Marconi sat in a room of a disused barracks on Signal Hill, St. John's, Newfoundland. On a table stood some instruments connected by a thin wire with a kite that was upheld at a height of about 400ft. by an Atlantic gale. Shortly after noon Mr. Marconi heard in a telephone connected to the instruments sounds which gave evidence that in far distant Cornwall the rhythmical signals that correspond to the letter "S" in the Morse code had been projected into the ether and had actually crossed the Atlantic. The result of this experiment was to prove that the curvature of the earth did not constitute an obstacle to the transmission and reception of wireless messages, and it gave such an impetus to the development of communication by wireless telegraphy that within a few years after the signal "S" was first heard by wireless across the Atlantic every important country in the world possessed a wireless telegraph organisation, and wireless messages were sent as a daily occurrence from one side of the world to the other. The interest of this historic achievement is increased by the fact that quite recently—in fact, almost twenty-five years after communication was established between this country and America—Mr. Marconi has succeeded in putting his short-wave beam system into commercial service and has thereby made another valuable contribution to the art of wireless communication.

Electricity Supply in America.

AT an informal meeting held at the Institution of Electrical Engineers a few days ago, a discussion on the trend of electrical development in the United States was opened by Mr. Ll. B. Atkinson. The most striking features of electricity supply in America were, Mr. Atkinson said, the tremendous concentration of distribution within small localities and the remarkable concentration of electricity supply duties in the hands of a few public utility companies. The single area of New York presented a load of 800,000 kilowatts, whilst that of Brooklyn was 250,000 kilowatts. The skyscraper offices, containing 30,000 and in some cases 40,000 people, gave rise to a very compact demand, which was repeated in the enormous apartment houses. As the supply was generally provided by the three-wire, 230–115-volt system, the streets were often congested with cables, and the difficulties in that direction had not yet been overcome. Apart from size, the generating stations using coal did not differ greatly from those in this country, although at Boston a turbine working at a pressure of 1200 lb. per square inch had been put into operation. The general domestic load did not seem to have advanced as far as it had done in some European countries, owing apparently to the cost of current, which, after allowing for the difference in money values, was not so cheap as in many parts of England. Colonel R. E. Crompton remarked that he recently visited the United States in the hope of learning something, but he had been disappointed, for problems of vital importance to us did not seem to concern the people of America. Our careful and delicate control of capital costs did not exist in the United States, and the wasteful use of electric lighting had no parallel. He praised the American systems of electric welding, which he considered to be better than our own.

Tidal Power.

ANOTHER scheme for the utilisation of tidal waters for the development of power on a fairly extensive scale was put forward by Professor A. R. Fulton at the meeting of the Dundee Branch of the Institution of Electrical Engineers, held on the 17th inst. The cost of the proposed works seems to us to be prohibitive unless assistance can be obtained by the incidental inclusion of road improvements. The proposal is to enclose Invergowrie Bay, from the west end of Dundee Esplanade to Port Allen, by an embankment 9 miles long, and to subdivide the enclosed space by a median wall. The total area impounded would be 9 square miles, and it is estimated that 11,700 horse-power could be developed continuously. The cost of the main walls is put at £1,200,000, and that of the machinery at £250,000, making a total of £1,450,000. This amount works out at a cost of approximately £124 per horse-power, but it is pointed out that if the embankment were utilised as a roadway, to improve the route to Edinburgh, and a contribution were consequently obtained from the road funds, the cost per horse-power might be brought within the region of practical politics.

Cast Iron.

THE annual general meeting of the British Cast Iron Research Association was held at the Hotel Cecil on Wednesday last, and was followed by a luncheon, at which Sir Frank Heath, Department of Scientific and Industrial Research, was the principal guest. Sir Frank, referring to the work of the Association, agreed that it ought to get as soon as possible its own experimental foundry, and he congratulated it on having added Dr. A. L. Norbury to its staff. Discussing the value of research into cast iron, Sir Frank said that there was one direction in which the work upon which the Association was engaged might be regarded as holding out an exceptional prospect. Low-temperature carbonisation of coal, which had to come, required retorts which would stand a temperature of 650 deg. Cent. They would be of cast iron. Some already produced would stand that temperature, others would not. The reason for the difference should be sought, and the regular provision of satisfactory retorts should be assured. It was probable that the low-temperature carbonisation process would involve an expenditure of £100 millions, of which one-quarter perhaps would go to the foundries.

Armstrong-Whitworth's New Policy.

THE directors of Sir W. G. Armstrong, Whitworth and Co., Ltd., issued at the end of last week particulars of the scheme whereby they hope to overcome the difficulties in which the company finds itself. The company's total capital aggregates £24,400,120. In 1924 the total profit earned on this sum was £335,965, but in 1925, after making provision for special losses and all interest charges, there was a deficiency of £1,123,413. The directors propose that a moratorium as regards the payment of interest should be agreed to for a maximum period of five years by the holders of the 6½ per cent. second mortgage debenture stock, the 6½ per cent. consolidated mortgage debentures and the 5½ per cent. three-year notes. There is to be no reduction of capital as was carried out in the case of the Vickers' reconstruction. In a circular to the noteholders and shareholders the directors point out the difficulties encountered in changing over from war to peace conditions. The policy adopted was twofold, namely, to seek investments in outside businesses and to undertake civil engineering contracts, in the expectation that substantial work would be provided for the Elswick and Openshaw establishments. Neither direction, particularly the second named, proved successful. Certain of the civil engineering work undertaken turned out disastrously. An outstanding example of an unfortunate investment is stated to have been that in the Newfoundland Power and Paper Company, Ltd. This undertaking stands on the company's books at £2,864,184, and on this sum there is little prospect of any return in the near future. The company has in all about £10,000,000 invested in undertakings foreign to its original business on which no return is being made or is likely to be made for some time to come. Certain of the companies, including the Newfoundland Company, are believed to have possibilities, but intensive work and considerable time must be spent on them before their possibilities are realised. It is hoped that the five-year moratorium will afford the company sufficient time to recover its situation, but in financial circles the scheme has not been received with universal approval.

Reinforced Concrete Silos at the Ougrée-Marihaye Steel Works.

No. II.*

THE condition of the site of the silos as it appeared in July, 1924, is shown in illustration No. I. in the Supplement accompanying this issue. In the foreground is to be seen one of the machines engaged in placing the Franki reinforced concrete piles which support the vertical load of the immense structure. The special feature of these piles is that they are formed in position, and it is claimed for them that, by the nature of their construction, they have a supporting power greatly in excess of that of an ordinary driven pile. To make a pile, steel tubing closed at the bottom by a pointed plug is first driven to the required depth. The shaft thus formed is filled with concrete, the tubes being slowly and progressively withdrawn as each charge of concrete is poured and rammed. The tubing consists of a set of two or more concentric steel tubes, each 3 m., 4 m., or 6 m. long, sliding one into the other telescopically. The tubes are placed vertically against the uprights of the machine. A cast steel pointed plug is inserted into the smaller tube and bears against an internal flange at the base of the latter. The plug carries a central tail-rod 4 m. or 5 m. long, which forms a guide for a 2-ton monkey. By the blows of this monkey on the plug the tubes are driven, each tube carrying the next one with it by engaging flanges after the fashion of a telescope. Since the driving force is applied to the plug at the bottom of the tubes, the latter are in tension and are therefore driven vertically. When the desired depth has been reached the monkey and plug are taken out, the removal of the latter leaving a tapered cavity about ½ m. long below the tubing. This cavity is filled with concrete, which is strongly rammed by means of a tup weighing 900 kilos., dropping from 4 m. to 5 m. The point of the tup forces the concrete laterally into the surrounding soil and makes an enlarged foot for the pile. If reinforcing rods are to be used their ends are then inserted into the concrete. They serve as a guide for the hammer during subsequent ramming and as a connection between the pile and the raft or other structure which rests on it. As ramming and concreting proceeds the tubes are slowly withdrawn, care being taken not to lay bare any portion of the earth walls in order that no loose earth may fall and mix with the concrete. When the pile is completed and all the tubes have been withdrawn, several blows of the monkey are given to the head of the finished pile with a drop of the full height of the derrick. This swells out the head of the pile, making it from 80 cm. to 150 cm. in diameter, according to the nature of the ground.

We have described the general mode of procedure adopted when the resistance to the penetration of the point of the pile casing is greater than that due to the friction of the tubing in entering the soil. When the conditions are reversed, or when the soil is extremely water bearing or soft, somewhat different methods are employed. In some cases, instead of the removable steel plug, a concrete plug is employed. The blows of the monkey do not fall directly upon the concrete plug, but are transmitted by means of a wooden dolly resting on the latter. Another alternative comprises the use of a short pile of wood or of pre-cast concrete as a point. This is sealed into the inner tube by a thin layer of concrete and the two are driven simultaneously. When the desired depth has been reached the anvil and dolly are removed, and the concreting and withdrawal of the tubes is started. The original short pile is left embedded in the base of the main concrete pile, the whole proceeding being carried out without the possibility of water or mud entering the hole. Whatever the details of the operation, the general principle is always the same, the idea being to produce a pile cast and rammed in place, having a tapered section and a surface rugosity giving the maximum possible supporting power. The piles can be constructed directly in water, should that be necessary, and it has indeed been done in several cases, notably for the foundations of the bridges of the Società Nazionale di Ferrovie e Tramvie di Roma at Orbetello, on the shores of the Mediterranean Sea.

The machine by means of which the piles are constructed consists, as will be gathered from illustration No. I., of a kind of derrick operated by a steam winch with a vertical boiler. The derrick is 9 m. high and at the base there is a screw jack appliance which may be adjusted to rest on the ground in order to carry the extra load imposed on the soil when the machine is engaged in drawing the tubes. The steam engine, of the two-cylinder type, is fitted with reversing gear. There are two winding drums on the winch. One drum operates the 2-ton monkey for driving the tubings and subsequently the 18 cwt. tup for concreting. The other drum actuates the cable gear for withdrawing the tubes. The machine is self-contained and does not require any guys or bracing to ensure stability. Two men only are required for the actual work of making the piles, one to drive the derrick and another to supervise the ramming.

The state of the work in January, 1925, is shown by illustrations Nos. II. and III. in our Supplement. The crane for distributing the concrete is seen in the former illustration. The tower of this crane had an overall height of 36 m.—118·1ft.—and a clear length of horizontal arm of 34 m.—111·5ft. The concrete was brought to the foot of the tower by dump wagons, the bodies of which were raised in the centre of the tower and emptied on to a belt conveyor running the full length of the arm. A movable arrangement allowed the concrete to be dumped at any point along the arm. As the tower was mounted on rails, it commanded a very large area. This tower, which was constructed by the Société Générale de Matérial d'Anvers, laid 150 cubic metres of concrete per average day of ten hours and occasionally as much as 225 cubic metres were laid. It was found inadvisable to let the concrete have a clear fall of more than 2·5 m. because the mixture was impaired, so that shoots were arranged to guide it to its destination. The tower was not used in the construction either of the coal silos or the coal preparing house, because the concrete in those cases was in smaller masses and heavily reinforced, and, moreover, a wetter concrete was indicated for the work. It may be said that the whole of the concrete was made with slag from the blast-furnaces adjacent. A nearer view of the tower in shown in Fig. 10, page 664. By April, 1925, the work had reached the state shown in illustration No. IV. in the Supplement. The view is taken from the top of the 18 m. bank, and in the foreground is to be seen the construction of the wall, which acts at the same time as a retaining wall for the bank and as a side to the ore bins. A corner of the interior of one of these bins is shown in Fig. 11, page 664. The wall to the right is a division wall—as shown in Fig. 4 *ante*—and that to the left a buttress wall of the type illustrated in Fig. 3 *ante*. As will be seen from the engraving, the corners of all the buttresses are armoured with angle irons. The travelling crane is to be seen above, in course of construction, and the magnitude of the bin will be gathered from the figures of the two men standing within it.

THE COAL PREPARATION HOUSE.

This building, which measures 40 m. by 30 m. in plan, is 32 m. high and descends 4 m. below the level of the river bank. As will be seen by reference to the drawing on page 634 *ante*, it is divided longitudinally into two parts, on one side being eighteen silos, each 4 m. by 6 m. by 15 m. deep, and the other side being occupied with floors for various machines for crushing, conveying, &c. At a level of 18 m. above the river bank the whole building is crossed by great beams carrying the railway tracks. The building is covered in by two parabolic roof spans in reinforced concrete. The appearance of the coal preparation house in course of construction is shown in illustrations Nos. V., VI., and VII in the Supplement, taken respectively in June, July and August, 1925. In all these illustrations a prominent feature is the great cantilever structure on the land side at the end of the building. The object of this structure is to carry a platform 18 m. long by 14·30 m. wide, which forms the foundation and the loading station of the aerial transporter for carrying the coal over the railway to the coke ovens. The total load to be carried is 1308 tons. The immensity of the struts will be gathered from Fig. 12, page 664, in which a man can be seen standing at the foot of one of them. Fig. 8 is a view taken in the interior of the house on what may be called the ground floor, and the façade as seen from the bank of the Meuse is shown in Fig. 13.

The roof of the building is, as has been said, of reinforced concrete. It comprises two spans, one 20·40 m. and the other 10·20 m. in width. The roof principals are of parabolic form, placed at 6·50 m. centres. The section of the arch of the larger span is 60 cm. by 30 cm., and that of the smaller span 40 cm. by 20 cm. The tie-rods, also of reinforced concrete, measure respectively 40 cm. by 30 cm. and 30 cm. by 20 cm. The big principals have a rise of 3·50 m. at the centre and the small ones a rise of 1·75 m. To avoid extensive shuttering, the roof was constructed of hollow concrete blocks, about 20 cm. deep, laid on light reinforced concrete purlins of 7 cm. by 7 cm. section, each reinforced by a T iron. The purlins were laid on the principals at about a third of a metre apart, and when the blocks were in position the whole was grouted together. A layer of grout, 2·5 cm. thick, covered the blocks, and watertightness was secured by two layers of single-ply roofing material. Three layers were used to line the gutters. The roof weighs 280 kilos. per square metre, exclusive of the principals.

The basement of the coal preparing building, with its walls and flooring of reinforced concrete, had to be made proof against external water pressure, for during the floods of the Meuse it would have to withstand a head of 5·70 m. of water. As the concrete alone could not be depended on for water-tightness, it had to be covered both internally and externally with a wash of waterproof material over a surface of about 3500 square metres. The result of the treatment was all that could be desired, the basement remaining perfectly dry during a subsequent exceptional rise of the river. The exact process employed was described in detail by Professor Magnel in the articles to which we have referred. The concrete was first roughened by pneumatic tools and then washed with a hose pipe to clear away the dust and moisten the concrete. The surface thus prepared was immediately treated with a grout of pure cement, and then without delay the water-tight coating was commenced. This, which had a final thickness of 2 cm., was put on in several layers, each layer being added at the moment when the preceding layer had just the necessary resistance. The last layer was worked energetically with a steel trowel to close the grain and make a polished surface. The coating was kept moist by frequent waterings for at least eight days after being laid. Care was taken to avoid as far as possible all stoppages and restarts of the work, and when stoppages were necessary the layer was tapered off to a length of 10 cm. to 15 cm. at the edge, this tapered part being roughened and damped before

FIG. 8—INTERIOR OF COAL PREPARING HOUSE—JULY, 1925

FIG. 9—SHOOTS UNDERNEATH COAL SILOS

* No. I. appeared December 10th.

the recommencement of the process. All corners, whether external or internal, were well rounded off. The mixture of the waterproofing material recommended by Professor Magnel was as follows:—One part by volume of the best Portland cement to two parts of Rhine sand, 3 kilos. of "Pudlo" being incorporated with every 100 kilos. of cement. The constituents were combined as follows:—The cement and the "Pudlo" were mixed dry, the mixture was then passed through a screen of 2 mm. or 3 mm. mesh, spread on dry screened sand, and the whole then mixed with a shovel. Water was next added by a watering can, and mixing was continued till the mass was completely homogeneous. It was never used more than an hour and a half after being mixed. The final result justified the meticulous care taken with the waterproofing, and as the flooding of the basement might have most seriously interfered with the output of the great Ougrée works, cost was not a primary consideration.

THE COAL SILOS.

The coal silos occupy in plan a length of 100 m., and are of the same width as the other constructions, namely 30 m. The side walls rise to a height of 18 m. above the river bank, and at that level they support the beams carrying the railway lines, which extend through the adjacent coal preparation house and along the ore bins. The silos comprise thirty bins of 10 m. square, and can hold 300,000 cubic metres (about 24,000 tons) of coal. The roof is a continuation of that already described in connection with the coal preparation house. The walls of the silos, which lie against the high bank, form a retaining wall, and, as in the case of the coal preparation house, this wall is stable, independently of the silos, and its footing is supported by inclined piles. Under the columns of the building, where the loads are vertical, Franki piles are used. A cross section of the coal silos has already been illustrated on page 634 *ante*. The construction of the hopper bottom is shown in illustration No. VIII. in the Supplement, and Fig. 9 gives a view of the shoots beneath.

The appearance of the finished building with the ore and coal silos, as seen from across the Meuse, will be gathered from the half-tone engraving given on page 634 *ante*. The whole constitutes one of the largest works in reinforced concrete ever carried out in any country. The construction involved the driving of 4959 piles of reinforced concrete and the manufacture and casting of no less than 61,000 cubic metres of the same material in fifteen months. The steel used for reinforcement weighed about 3500 tons. The whole of the concrete was made from blast-furnace slag, a procedure which saved the company an immense sum of money, as its blast-furnaces were on the spot. As regards the quality of the concrete, the rich concrete, containing 406 kilos. of slag cement to 1623 litres of broken and ground slag, had a resistance of 234 kilos. per square centimetre after four weeks and 290 kilos. per square centimetre after three months. The weaker concrete, composed of 147 kilos. of slag cement to 1695 litres of slag aggregate, gave tests of 58 kilos. and 71 kilos. per square centimetre respectively. The reinforced concrete piles made with the rich mixture were driven, after five weeks, by a 3¼-ton monkey falling 1 m.

The work was carried out by La Compagnie Internationale des Pieux Armés Franki, of Liége, and was completed in twenty-five months, under the supervision of Professor G. Magnel, of Ghent, as consulting engineer.

Models and Analogies for Demonstrating Electrical Principles.

No. XIX.*

AT a meeting of the Physical Society held on October 27th, 1899, Mr. G. L. Addenbrooke exhibited a model for illustrating the flow of an electric current in a circuit under various conditions. The model is illustrated in Fig. 152, where A, B and C are three discs revolving on hollow axles carried on supports, as shown. The discs B and C are grooved and are connected by a band, the disc C being provided with a handle K for rotating the mechanism. D and E are two long spiral springs made by winding pianoforte wire tightly on a mandrel in a lathe, and through these springs and the hollow axles on which the discs A and B are mounted a fairly thick, soft copper wire is threaded, the ends of which are united by a brazed joint. The springs are soldered or clamped to the ends of the hollow spindles. All corners round which the copper wire passes are well rounded.

If the crank K is turned the pulley B will revolve and will twist the spiral springs, and the twist will soon exert a torque on the axle of the disc A and cause it to turn. The whole moving mechanism is, in fact, a vortex ring involuting on itself. If, whilst the crank K is still revolving, a slight restraint be applied to the disc A, say, by applying a light pressure to it with the finger, then before the disc A can be rotated a torque must be exerted on both springs, one being tightened and the other slackened. This represents the state of affairs in a symmetrical circuit in which B is the generator giving an equal difference of potential with respect to earth at each pole, but positive on one side and negative on the other. The springs revolve equally and in opposite directions, but give a turning movement in the same direction to the disc A.

The copper wire inside the springs does not move or carry energy, but merely serves to direct its flow, as can be demonstrated by altering the curvature of the copper wire which the springs will follow, at the same time continuing to revolve when a torque is applied at B. The torque, coiling and uncoiling the springs, represents the charge into the capacity of a circuit, and it will be perceived that it leads and

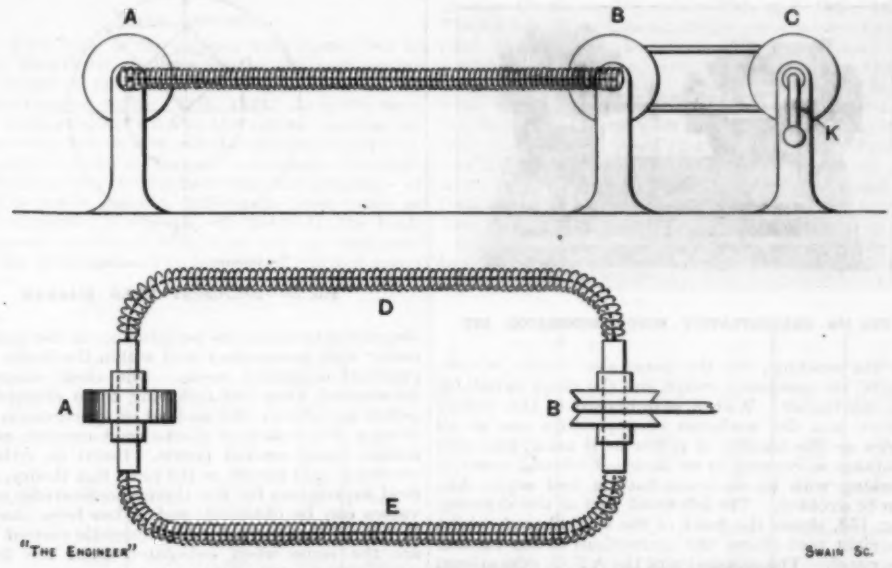


FIG. 152—MODEL FOR ILLUSTRATING THE FLOW OF AN ELECTRIC CURRENT

must be established before enough energy is stored to turn the disc A, which may represent an electric motor. The effect of self-induction can be shown by clamping a disc having some weight to one of the coiled springs. The loaded spring will then be seen to lag behind the unloaded spring. By turning the disc B half a revolution forwards and then half a revolution backwards an alternating current can be imitated, and the effect of lead and lag under these conditions can be shown.

The model was designed at a time when electricians were devoting considerable attention to the actions taking place in an electrical circuit, and was intended to illustrate that the propagation of energy was through the ether represented by the springs, and not through the wire, and to show visibly the effects of capacity and inductance in a circuit. Mr. Addenbrooke points out that if the wire conductor could be made sufficiently flexible, the rotation of the springs would carry it slowly forward, thus imitating the flow of electrons which constitute the current.

It will be seen that the electric and magnetic components of the current are also represented properly and at right angles to each other, though with definite boundaries, and not permeating the surrounding ether, this part of the action being impossible to represent properly by mechanical means.

In a previous article we described various pieces of apparatus employed for teaching electrical engineering in the works school of the A.E.G. Company, including demonstration switchboards and direct and alternating-current machine desks for demonstrating the performance of direct and alternating-current machines running individually and in parallel, in combination with regulating sets and in cascade connection under all conditions between no load and full load.†

The direct-current desk contains four direct-current motors, each rated at ¾ kilowatts, and designed for a speed of 1800 revolutions per minute. There are two shunt motors, and two series machines, and any two motors can be directly or indirectly connected together by flexible couplings, which are easily manipulated by hand levers without moving the motors on the iron underframe. The three-phase machine desk contains four 1½ kilowatt machines, each running at 1500 revolutions per minute. On the left of the desk there is an induction motor, in the centre two synchronous motors, and on the right a synchronous converter. A folding bracket behind the motors supports the speed indicators, which are coupled to the motors by means of a belt, and the necessary instruments, i.e., voltmeter, ammeter, and wattmeter. Each of the motors has its starter, regulators, switches and fuses fixed to a panel mounted on a steeply inclined plate. A battery of lamps for loading the machines is placed in a cupboard below the panels, and is protected by sheets of expanded metal. With the aid of these desks a great many instructive experiments may be carried out. In the case of the three-phase desk, for example, it is possible to demonstrate the principle of synchronising, the parallel operations of machines, frequency changing, phase advancing, and methods of starting, synchronous and induction motors, &c. In conjunction with these machine desks a motor generator is used for supplying either of the two kinds of current required at the desired voltage. The set consists of a three-phase asychronous 220-volt motor driving a rotary converter, which provides direct current at a pressure

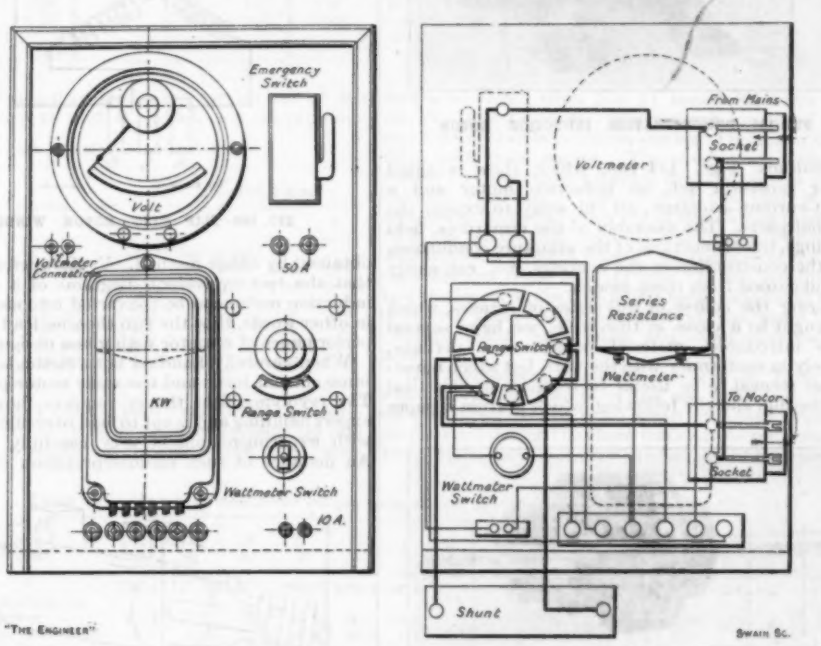


FIG. 153—CONNECTIONS FOR PORTABLE SWITCHBOARD

* No. XVIII. appeared December 10th.

† See THE ENGINEER, August 20th.

of 105 volts and three-phase alternating-current at a pressure of 60 volts.

From the A.E.G. Company we have since this series began received particulars of several educational arrangements which we shall now briefly consider. A movable measuring switchboard is used for measuring the power supplied from the mains to various machines in the workshop. As the board is mounted on rollers, it can easily be brought up to any desired machine. Plug connections serve for connecting up the mains and the machine under test—as shown in the diagram of connections, Fig. 153. The chief instrument on the panel is a three-range wattmeter which shows the actual power being consumed

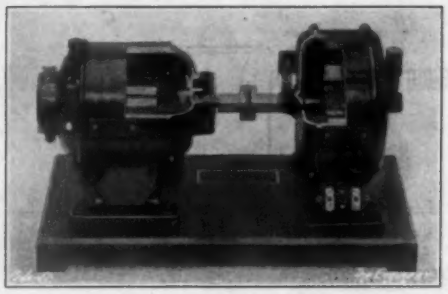


FIG. 154—DEMONSTRATION MOTOR GENERATOR SET

by the machine, but the panel also carries a voltmeter, an emergency switch and the range switch for the wattmeter. With a switchboard of this nature before him the workman or apprentice can at all times see the amount of power he is using, and such mistakes as running at an incorrect turning speed or working with an incorrect cutting tool angle, &c., can be avoided. The left-hand part of the drawing, Fig. 153, shows the front of the switchboard, whilst the right part shows the connections at the back of the panel. The remainder of the A.E.G. educational equipment is more or less self-explanatory from the

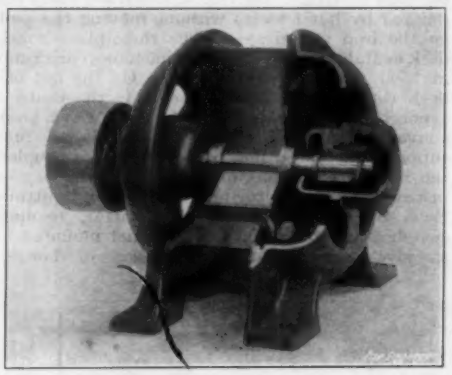


FIG. 155—DEMONSTRATION INDUCTION MOTOR

illustrations, Figs. 154–156, which show a small motor generator set, an induction motor and a direct-current armature, all cut away to expose the internal parts. The assembly of the armatures, field windings, the connections of the armature conductors, and the construction of the bearings, &c., can easily be understood from these models.

During the course of this series of articles, which is brought to a close in this issue, we have several times introduced material which was, perhaps, scarcely in conformity with the title, but which nevertheless seemed to be useful to teachers of electrical engineering, and the following, which is from a paper

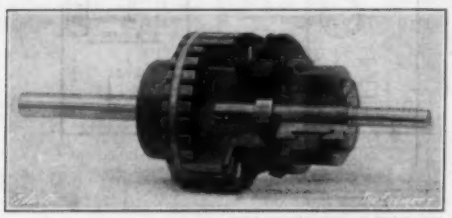


FIG. 156—DEMONSTRATION ARMATURE

on "Physical Conceptions of Induction Motor Operation" by Mr. J. Lebovici, appearing in the *Journal* of the American Institute of Electrical Engineers of November, 1921, is now added. It is but natural, the author states, that in order to familiarise ourselves with the behaviour of the single-phase induction motor we should substitute for the direct the indirect description and explain the single-phase motor by means of the better-known polyphase performance. Yet in the same manner as it has been found advisable to abandon the indirect method of describing heat phenomena by means of Black's heat substance, it may be preferable to abandon the explanation of the single-phase motor performance by the polyphase motor. Of the direct methods, that originated by Potier and Görges and developed by V. Fynn, McAllister and others carefully studies the action of the secondary rotating member in the production of a field at right angles in space and in time phase to the transformer field. Since the right-angle field is generally called the speed field or cross flux, the direct method can be referred to as the cross flux theory and the indirect method as the revolving field theory.

It is known that the circular current locus or circle

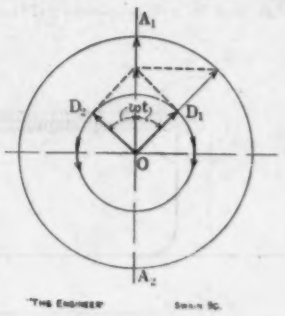


FIG. 157—COMPONENT FIELD DIAGRAM

diagram determines the performance of the induction motor with an accuracy well within the limits of the practical engineer's needs. The circle diagram is determined when the following three characteristic points are given: the no-load or synchronous speed current, the locked or short-circuit current, and the infinite speed current points. Based on either the revolving field theory or the cross flux theory, analytical expressions for the three characteristic current values can be obtained, and it has been shown by E. Arnold that the three characteristic current values are the same when calculated from the formula

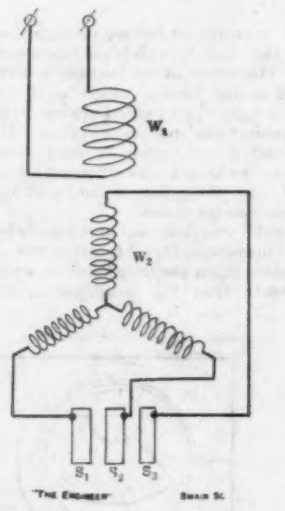


FIG. 158—SLIP RING MOTOR WINDINGS

obtained by either method. V. Karapetoff has shown that the two equivalent diagrams of a single-phase induction motor can be converted into each other, or, in other words, that the two theories lead to the same performance of a motor with given design constants.‡

When carefully handled both methods lead to the same current locus and the same motor performance. The revolving field theory requires, however, more expert handling and is apt to lead to results at variance with experiment unless very carefully interpreted. An instance of such misinterpretation is as follows.

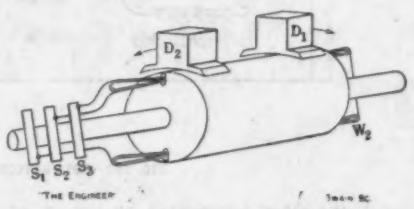


FIG. 159—ROTOR AND IMAGINARY FIELD SYSTEM

The revolving theory assumes that a single-phase alternating magnetic field (see Fig. 157) may be considered to be made up of two fields $O D_1 = O D_2 = \frac{1}{2} O A_1$ of constant value and rotating at uniform speed in opposite directions. Consider on the basis of this theory the electromotive forces generated in the secondary of the slip ring motor shown in Fig. 158, the primary winding W_1 being connected to a single-phase line, the secondary winding W_2 being stationary and

‡ See *Journal* of American Institute of Electrical Engineers, 1921, page 640.

open circuited. For the sake of simplifying matters Fig. 159 has been drawn showing the rotor core of sufficient length to accommodate the two oppositely revolving fields D and D_2 of constant value.

Applying the knowledge obtained from a familiarity with polyphase induction motors to the field D_1, we might expect that it would generate a system of balanced voltages in the secondary winding W_2.

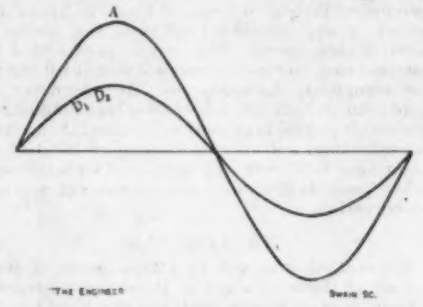


FIG. 160—FIELD CURVES

Similarly, the revolving flux D_2 would produce a system of balanced voltages in the same windings W_2, and as a resultant we might expect a balanced voltage between slip rings S_1, S_2 and S_3 or otherwise zero voltage. But experiment and unbiassed consideration of Fig. 158 will prove that the secondary voltages are neither zero or balanced, and that the effective voltages measured between slip-rings S_1, S_2 and S_3 are dependent upon the relative position of the rotor with relation to the stator. The discrepancy is due to improper application of the revolving field theory and it shows the defect of the indirect method. At the instant shown in Figs. 160 and 161 the magnetic flux set up by the primary winding W_1 is at its maximum value. According to Fig. 157, the two component fields D_1 and D_2 will coincide both in space (see Fig. 160) and time value. Since in Fig. 161 at the instant considered the fields D_1 D_2 are both positive with respect to the rotor W_2 and are rotating in opposite directions the instantaneous value of the electromotive forces generated in the winding W_2 will be zero.

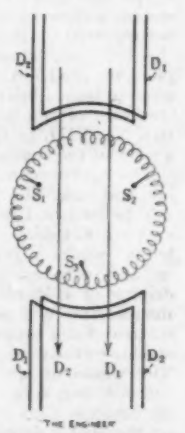


FIG. 161—ZERO VOLTAGE CONDITIONS

A quarter of a period later the value of the flux A has decreased to zero, and, according to Fig. 157, the rotating fields D_1 and D_2 will have the time and space values shown in Figs. 162 and 163. If D_1 is considered positive with respect to the rotor winding W_2, the field D_2 will have to be considered negative, and as the

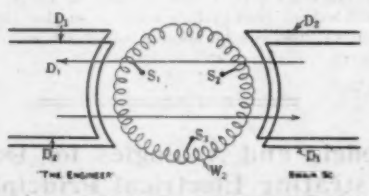


FIG. 162—UNBALANCED VOLTAGE CONDITIONS

field D_1 is positive and travelling clockwise, while the field D_2 is negative and travelling counter-clockwise, the electromotive forces generated in the windings W_2 will add up along a vertical axis in Fig. 162. The generated electromotive forces add between the slip-rings S_1 and S_3, but oppose each other between the rings S_1 and S_2, and this explains why the effective voltages measured between the slip-rings S_1, S_2 and S_3

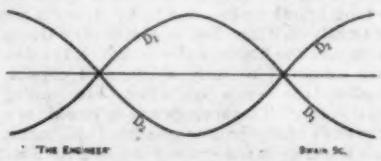


FIG. 163—COMPONENT FIELD CURVES

will be unbalanced under the conditions assumed. Proceeding by the direct method, we would look upon Fig. 158 as a static transformer having the secondary open-circuited, and since the various secondary phases are not in the same inductive relation with respect to the primary winding we would naturally expect unbalanced secondary voltages.

In deriving the induction motor performance by means of the revolving field theory, Mr. Lebovici

points out, we lose track of the important part played by the secondary leakage in the motor performance. The action of the secondary leakage in improving the power factor of all induction motors is not appreciated, and the means for improving the power factor of induction motors by the use of phase advancers or the substitution of a commuted secondary winding for the short-circuited windings are not apparent, but, on the other hand, when proceeding by the cross flux theory these phenomena are quite evident. This is one reason why the action of the polyphase induction motors and of single-phase induction motors with and without commutators should be studied by the direct method rather than in a roundabout way by means of the rotating field theory.

Marine Oil Engine Trials Committee.

ON Friday last, Dec. 10th, a joint meeting of the Institution of Mechanical Engineers and the Institution of Naval Architects was held in London at the home of the first-named body for the purpose of hearing and discussing the fifth report of the Marine Oil Engine Trials Committee. The Committee's previous reports and the issues in which we dealt with them were as follows :—

Report	Ship.	Engines.	Issue.
First ..	Sycamore* ..	Richardsons-Tosi	Nov. 28th, 1924
Second ..	Dolius	Scott-Still ..	March 27th, 1925
Third ..	Pacific Trader	Doxford	Jan. 15th, 1926
Fourth ..	British Aviator	Palmer-Fullagar	June 4th, 1926

* Renamed Castilian Prince.

The fifth report deals with the trials of the twin-screw motor vessel Cape York, and is summarised below.

TRIALS OF THE T.S.M.V. CAPE YORK.

The Cape York is a vessel of 424ft. overall length, with a fully loaded displacement of 12,465 tons and a deadweight capacity of 9000 tons. She was built by Lithgows, Ltd., and is propelled by two six-cylinder, six-crank, four-stroke cycle single-acting "Werkspoor" engines, built under licence by R. and W. Hawthorn, Leslie and Co., Ltd. The fuel admission is effected by blast air from an engine-driven compressor, and firing is obtained by the compression temperature. Each engine is rated to develop 1020 brake horse-power at 125 revolutions per minute. With this power, and in the fully loaded condition, the ship was designed for an estimated service speed of 10½ to 11 knots. The two propellers are driven direct from the engines. They are made of cast iron with four blades solid with the boss. They measure 12ft. over the tips and have a uniform pitch of 10ft. In Table I. we give a statement of the weights of machinery in the engine-room.

TABLE I.—*Weights of Machinery in Engine-room.*

Part.	Weight, tons.
Main engines, complete with all pipes and fittings, including thrust blocks and shafts, but excluding fly-wheels	288·0
Fly-wheels	11·0
Shafting, stern gear and propellers	60·0
Boiler, hotwell tank, oil-fuel burning plant, steam and steam exhaust pipes	10·5
Auxiliaries, pipes and fittings: Fuel oil system	12·8
Auxiliaries, pipes and fittings: Cooling water system	4·0
Auxiliaries, pipes and fittings: Lubricating oil system	5·7
Auxiliaries, pipes and fittings: Gas exhaust system	6·3
Auxiliaries, pipes and fittings: Pumping system (bilge, ballast and general service pumps)	13·5
Auxiliaries, pipes and fittings: Electric generator system	55·7
Fittings on board—funnel complete, engine-room floors, ventilators, gratings, workshop, lifting gear, tools and outfit	45·0
Air reservoirs	27·3
Spares—main engines and auxiliaries, including two spare propellers and tail end shaft	21·5
Total	561·3
Water in system and in reserve	0·8
Water in boiler	2·2
Water in reserve feed tank	33·0
Lubricating oil in system and in reserve	11·0
Total	47·0
Total running weight	608·3

The fifth report deals with the trials of the twin-screw motor vessel Cape York, and is summarised below.

TRIALS OF THE T.S.M.V. CAPE YORK.

The Cape York is a vessel of 424ft. overall length, with a fully loaded displacement of 12,465 tons and a deadweight capacity of 9000 tons. She was built by Lithgows, Ltd., and is propelled by two six-cylinder, six-crank, four-stroke cycle single-acting "Werkspoor" engines, built under licence by R. and W. Hawthorn, Leslie and Co., Ltd. The fuel admission is effected by blast air from an engine-driven compressor, and firing is obtained by the compression temperature. Each engine is rated to develop 1020 brake horse-power at 125 revolutions per minute. With this power, and in the fully loaded condition, the ship was designed for an estimated service speed of 10½ to 11 knots. The two propellers are driven direct from the engines. They are made of cast iron with four blades solid with the boss. They measure 12ft. over the tips and have a uniform pitch of 10ft. In Table I. we give a statement of the weights of machinery in the engine-room.

TESTS ASHORE.

The shore tests of the engines were carried out at Messrs. Hawthorn, Leslie's works, the port engine being tested on December 10th–13th, 1923, and the starboard engine on May 17th, 1924. As in the cases of the engines dealt with in the earlier reports, the test loads and speeds were calculated from the approximate propeller law :—Torque = constant × speed³. The constant was determined from the condition of rated full power, namely, 1020 brake horse-power at 125 revolutions per minute. In Table II. the loads and speeds calculated from this law are indicated under the heading A. The high-speed and low-speed tests at each nominal load were carried out at the speeds marked B and C, which are respectively 15 revolutions per minute above and below the corresponding speed A. The method of conducting and the apparatus employed for the shore tests were in general similar to those used previously and described in our earlier issues. The fuel used during the shore tests was Shell-Mex Diesel oil, having a gross calorific value of about 19,200 B.Th.U. per lb.

TABLE II.—*Test Loads and Speeds.*

Applied external load. Nominal.	Torque.	Nearest brake. Load.	Speed, r.p.m. A. Calculated from propeller law.	B. High speed.	C. Low speed.
Full torque ..	42,800	3,259	125	140	110
¾ „	32,100	2,444	108	123	93
½ „	21,400	1,629	88	103	73
¼ „	10,700	814	63	78	48

RESULTS OF THE TESTS ASHORE.

The results of the shore tests are presented in the original report in seven tables and eleven diagrams. The information given is summarised in Table III. The thermal balance sheets are reproduced in full in Table IV. The tests numbered 1 to 12 were carried out at the loads and speeds prescribed in Table II., and were all conducted on the port engine. Test No. 13 was made on the same engine when developing power 10 per cent. in excess of its rating. Tests Nos. 14 and 15 were carried out on the starboard engine using British-Mexican boiler oil as fuel. This oil had a gross calorific value of 18,475 B.Th.U. per lb., and was heated before being used.

SEA TRIALS.

The sea trials of the Cape York were carried out on the Clyde on December 17th and 18th, 1925. They covered ten measured mile runs, referred to as runs Nos. 1 to 10, a starting-air consumption trial, a slow-speed test and two fuel consumption trials, referred to as runs Nos. 11 and 12. During these trials the ship was loaded to a draught forward of 8ft. 6in. and a draught aft of 16ft. 5in., as compared with 26ft. 0½in. forward and aft in the fully loaded condition. The ship's bottom at the time of the trials was not perfectly clean, but the amount of fouling was not enough to influence the speed more than to a slight extent.

In the case of runs Nos. 1 to 10, the ship was on her course four or five minutes before entering the measured mile. Run No. 11 lasted 3½ hours and run No. 12 four hours. During each measured mile run it was possible to obtain one set of indicator cards from each main engine. The revolutions were recorded on entering and leaving the mile, and at intermediate intervals. The level of the fuel in the measuring tanks was observed at one-minute intervals over the whole time for each run during which the ship was on a straight course. In the case of the fuel consumption trials Nos. 11 and 12, the revolutions and the levels of the fuel in the measuring tanks were observed every half-hour, and at the same time indicator cards were taken and other observations made.

The mechanical efficiencies entered in Table V., which gives the results of the sea trials, are those corresponding to the same mean indicated pressure as observed during the shore trials of the port engine. The "brake horse-powers" are the shaft horse-powers forward of the thrust blocks as deduced from the indicated horse-powers observed at sea and the mechanical efficiencies taken from the shore test results.

No attempt was made, as in some of the earlier trials, to take a direct reading of the thrust by means of a thrustmeter. On the port shaft a torsionmeter of the Ford type, lent by Siemens

TABLE III.—*Shore Trials.*

Test number :	A 13	B 8	A 10	C 9	B 5	A 7	C 6	B 1	A 3	C 2	B 4	A 11	C 12	A 15	A 14
Average speed, r.p.m.	128·9	138·0	125·1	109·6	123·1	108·5	93·0	103·7	88·4	72·8	79·3	63·3	48·7	126·9	124·0
Load on brake, lb.	3470	3259	3259	3259	2444	2444	2444	1629	1629	1629	809	814	814	3470	3259
Pressure in cylinders, lb. per sq. in.—															
At end of compression	475	465	460	465	460	465	460	455	455	445	450	450	445	480	485
Maximum during firing	645	620	640	650	580	610	625	595	615	630	595	570	545	595	570
At end of expansion	36	39	35	35	29	28	29	22	22	22	14	14	12	36	34
Indicated horse-power	1660	1700	1530	1350	1205	1080	915	785	645	540	425	355	255	1500	1420
I.H.P. (corrected)	1670	1675	1540	1375	1195	1075	950	745	660	570	380	340	300	—	—
Mean indicated pressure from I.H.P. (corrected), lb. per sq. in.	114·0	106·9	108·4	110·3	85·6	87·3	90·0	63·0	65·6	68·9	42·2	47·1	53·9	104·0	101·0
Total I.H.P. compressor	98	99	78	65	62	56	52	57	54	47	54	36	23	82	74
Brake horse-power	1118	1123	1018	893	753	664	569	422	360	297	160	129	99	1100	1010
Brake mean effective pressure, lb. per sq. in.	76·4	71·7	71·7	71·7	53·9	53·9	53·9	35·9	35·9	35·9	17·8	17·9	17·9	76·4	71·7
Friction horse-power	454	453	444	417	380	355	329	266	246	226	166	175	178	318	336
Mechanical efficiency	0·670	0·672	0·661	0·650	0·630	0·618	0·599	0·569	0·547	0·522	0·421	0·392	0·382	0·733	0·712
Fuel consumption—															
Quantity per minute (corrected), lb.	8·16	8·20	7·15	6·30	5 39	4·83	4·23	3·29	2·90	2·50	1·65	1·46	1·28	8·15	7·42
Weight per B.H.P. per hour, lb.	0·438	0·438	0·422	0·423	0·430	0·437	0·446	0·468	0·484	0·503	0·619	0·679	0·776	0·445	0·440
Weight per I.H.P. per hour, lb.	0·29	0·29	0·28	0·28	0·27	0·27	0·27	0·27	0·27	0·26	0·26	0·26	0·26	0·33	0·31
Thermal efficiency, B.H.P. basis	0·303	0·303	0·315	0·313	0·310	0·305	0·298	0·283	0·275	0·263	0·215	0·197	0·171	0·310	0·313
Thermal efficiency, I.H.P. basis	0·45	0·45	0·48	0·48	0·49	0·49	0·50	0·50	0·50	0·50	0·51	0·51	0·51	0·42	0·44
Exhaust gas temperature at end of manifold, deg. F.	667	660	623	592	524	489	459	368	338	315	239	233	231	655	632
Cooling water—															
Jackets, &c.:															
Quantity, lb. per minute	225	219	195	180	148	142	131	126	105	71	60	45	46	460	390
Heat rejected, B.Th.U. per minute	36·6	38·2	32·4	29·2	23·4	22·0	19·1	14·7	13·9	11·0	7·3	4·2	5·1	44·2	38·6
Pistons :															
Quantity, lb. per minute	115	113	108	98	91	77	84	57	50	45	33	26	27	—	—
Heat rejected, B.Th.U. per minute	9·4	9·5	8·8	8·0	7·3	6·3	6·2	4·3	3·8	3·2	2·3	2·0	2·0	—	—
Air compressor cylinders :															
Quantity, lb. per minute	263	252	202	195	267	266	270	265	272	272	275	205	204	—	—
Heat rejected, B.Th.U. per minute	1·44	1·84	1·37	1·33	0·96	0·72	0·81	0·79	0·73	0·54	0·83	0·62	0·57	—	—
Air compressor coolers :															
Quantity, lb. per minute	123	254	199	199	148	139	144	175	160	169	158	117	115	—	—
Heat rejected, B.Th.U. per minute	2·62	2·74	1·97	1·73	1·67	1·39	1·37 *	1·42	1·42	1·12	1·41	0·94	0·80	—	—

TABLE IV.—*Thermal Balance Sheets (all quantities in units of 1000 B.Th.U. per minute).*

Test number :	A 13	B 8	A 10	C 9	B 5	A 7	C 6	B 1	A 3	C 2	B 4	A 11	C 12	A 15	A 14
To heat in fuel	156·5	157·3	137·2	120·9	103·3	92·6	81·2	63·2	55·6	48·0	31·6	28·0	24·6	150·5	137·0
By thermal equivalent of—															
Brake horse-power	47·4	47·7	43·2	37·9	32·0	28·2	24·2	17·9	15·3	12·6	6·8	5·5	4·2	46·7	42·8
Air compressor horse-power	4·2	4·2	3·3	2·8	2·6	2·4	2·2	2·4	2·3	2·0	2·3	1·5	1·0	3·5	3·1
By heat rejected from—															
Jackets, &c.	36·6	38·2	32·4	29·2	23·4	22·0	19·1	14·7	13·9	11·0	7·3	4·2	5·1	44·2	38·6
Pistons	9·4	9·5	8·8	8·0	7·3	6·3	6·2	4·3	3·8	3·2	2·3	2·0	2·0	*9·7	*8·8
By heat carried away in—															
Exhaust gases	46·7	49·6	41·1	35·5	32·2	27·2	23·8	15·7	15·3	12·6	8·9	7·1	5·9	42·8	39·6
By radiation, &c.	12·2	8·1	8·4	7·5	5·8	6·5	5·7	8·2	5·0	6·6	4·0	7·7	6·4	3·6	4·1
	156·5	157·3	137·2	120·9	103·3	92·6	81·2	63·2	55·6	48·0	31·6	28·0	24·6	150·5	137·0

* Taken as 6·4 per cent. of heat in fuel, by analogy from Test No. 10.

Brothers, of Woolwich, was fitted. The instrument was placed on the shaft at the after end of the tunnel, and, accordingly, the torques recorded by it should be less than the torques deduced from the engine data by a small amount representing the losses in the shaft transmission.

In the Ford torsionmeter the twist of the shaft alters the air gaps of two opposed and balanced electric transformers mounted on the shaft. The alteration of the air gaps causes a current to flow in the secondary windings, proportional in amount to the twist of the length of shaft on which the sleeve of the instrument is mounted. The secondary current is opposed and balanced by current from an identical set of transformers forming the receiving instrument, the air gap of which can be altered by hand by means of a screw micrometer. The micrometer reading gives a measure of the twist on a time basis, the relationship being torque in 16ft. = micrometer reading × 1459.

From the results obtained during trials Nos. 11 and 12, it is calculated that the fuel consumptions in tons per day were for the main engines 10·38 and 6·89 respectively, for the generator engines 0·33 and 0·31, and for all purposes except the steam boiler and the galley 10·71 and 7·10.

Starting Air, Manœuvring and Slow-speed Trials.

The starting air trials carried out on the port engine with two—that is, one-half of the total number—reservoirs in use showed that with an initial available pressure of 274 lb. per square inch, forty-three starts were possible, the engine in each case reaching about 88 revolutions per minute. The average volume of free air used from start was 198 cubic feet and the lowest pressure at which the engine would start was 97 lb. During the manœuvring trials the compressor was in operation continuously, and all the starting air reservoirs were connected. The time intervals between the receipt in the engine-room of an order from the bridge and the attainment of the engine speed corresponding to that order were noted. Twenty-four manœuvres were carried out, and in the report the times occupied by them and the pressure in the starting air reservoirs before and after each order are tabulated. The whole of the twenty-four manœuvres were completed in a total time of 12 min. 42 sec. The slow-speed tests showed that the engines could be run at a speed of from 37 to 40 revolutions per minute.

The report was presented last Friday by Mr. C. W. J. Taffs, the secretary to the Committee. In the course of his remarks, Mr. Taffs intimated that in due course a paper correlating the results of all the five trials that had now been completed would be presented to the Institutions by Professor W. E. Dalby. Commenting on the performance of the Cape York, Mr. Taffs remarked that the mechanical efficiency of her engines as revealed by the shore trials was somewhat lower than might have been expected, but its lowness was perhaps not surprising in view of the number of pumps which the engines had to drive. During the sea trials the vessel was trimmed 8ft. down at the stern, and this fact undoubtedly affected the test results by causing the flow of fuel to the after cylinders to be excessive. The "Ford" torsionmeter was found to give very consistent results. The manœuvring trials showed that the manœuvring equipment was ample for its purpose, all the tests imposed by the Committee being fully met.

Sir Archibald Ross was called upon by the President to open the discussion. Sir Archibald, in the course of his remarks, said that as usual the logs at sea showed a better performance than that given during the trials. The Cape York had just returned from a 30,000-mile voyage. Her logs showed that fully loaded with a displacement of 12,540 tons she had accomplished a speed of 9·4 knots on the average for a consumption of 7·22 tons of fuel oil per day. That figure would possibly have been still better had bronze instead of cast iron propellers been fitted. From the naval architects' point of view, it was regrettable that trustworthy records of the thrust developed were not available for all the trials. There was still difficulty in determining the indicated horse-power of marine oil engines on a trustworthy basis. Even with the best indicators fair-sized errors were probable. On the Cape York the indicators undoubtedly gave results that were too high and therefore caused the mechanical efficiency to appear unduly low. That the indicators gave high results was confirmed by a study of the thermal efficiencies deduced from the test results. These efficiencies, Sir Archibald said, appeared to be too high, too near the ideal, to be true.

Mr. J. H. Narbeth said that the Werkspoor engine was a sound and substantial design, and was in considerable favour, particularly among continental nations. Its balancing was good and its lubricating oil consumption was low. Its mechanical efficiency, however, was exceedingly low. The figures given in the report were, in fact, startling as compared with the mechanical efficiencies recorded in the preceding four reports. They were so low that in order to account for the popularity of the design, he could only conclude that the engine possessed some excellent feature that was not brought out in the report. During the full-speed sea trial the engines ran at the rated speed of 125 revolutions per minute, and developed more than their rated power. Yet the ship's speed was just the designed speed, in spite of the fact that her displacement during the trials was only 5610 tons, as compared with the designed fully loaded displacement of 12,465 tons. Comparing the fuel consumptions per brake horse-power per hour of the five vessels tested by the Committee, he represented that of the Scott-Still engined vessel Dolius by 100 in each case, and got the following results for full and low power :—

Engines.	Full-power.	Low-power.	Percentage difference.
Scott-Still	100	100	50
Doxford	112	96	25
Fullagar	117	117	50
Richardsons-Tosi	120	135	70
Werkspoor	124	147	80

The change in the consumption between full and low-power in the case of the Werkspoor engines suggested that there was a great deal the matter with the ship's propellers. New propellers, he suggested, would give much better consumption figures.

Mr. Thomas Clarkson expressed surprise that on the Cape York, so far as the report showed, no steps were taken to recover the large amount of heat escaping in the exhaust gases. It was well known that in internal combustion engines generally, more heat escaped in the exhaust than was converted into work. The auxiliary boiler on an oil-engined vessel probably consumed about a ton of oil fuel per day. The whole of that consumption could be saved by the proper utilisation of the heat in the exhaust gases. Mr. Clarkson then showed a number of lantern slides illustrating the development of the Clarkson thimble-tube waste heat and donkey boiler. These boilers, of which we illustrated an example in our Olympia Exhibition Supplement of November 20th, 1925, as fitted on board the motor vessel Malabar, can be arranged with auxiliary oil burners for use when no exhaust gas is available, and with deflectors which permit the gases to be passed either through the boiler or direct to the silencer. A particular example which Mr. Clarkson described is fitted with a sleeve valve, which by-passes some or all of the gases in order that the steam production may be regulated to the requirements without having to blow off the excess. Mr. Clarkson stated that these thimble tube boilers might without harm be run dry, and that no indication had ever been received that they were responsible for any increase in the back pressure on the engine. In the case of some two-stroke cycle engines, it had been found that the addition of the boiler actually decreased the consumption of fuel oil at the engines. The reason, he believed, was that the boiler caused a sudden contraction of the gases which facilitated their exit and reduced the back pressure.

Mr. W. A. Tookey, by means of a series of diagrams thrown on the screen, drew additional attention to the peculiarities of the indicated horse-power figures given in the report. He showed that in all cases the fifth report figures when examined on the basis of mixture strength—B.Th.U. per cubic foot of cylinder volume—were far from being in agreement with the results of a similar analysis of the figures for the preceding four vessels. The conclusion he drew was that there was some defect in the method of driving the indicator gear on the Werkspoor engines. Mr. Tookey then proceeded to outline an analytical method for defining an ideal standard of comparison for the efficiency based on the observation of the exhaust gas temperatures.

Mr. Hamilton Gibson contributed to the generally expressed belief that the indicated horse-powers recorded in the report were too high. The Admiralty coefficient for the vessel—a quantity inversely proportional to the indicated horse-power—was only 137, whereas it should be at least double that figure.

Mr. G. S. Baker, of the National Experimental Tank, Teddington, also dealt with the question of the measurement of the horse-power. The Cape York, he said, was the third vessel fitted with Werkspoor engines of which he had studied the trial results. All had shown efficiencies of the order given in the paper. He had little doubt that the indicator results were wrong, and that the Werkspoor designers were responsible for the errors. The errors were consistent, and it was evident that the method of driving the indicators was not suited to the engine.* The torque measurements were the best so far obtained by the Committee. At the high speeds the discrepancy between the observed and the calculated torques was not more than 1 or 2 per cent., and it really appeared as if at last we had obtained a torsionmeter that would stand up to sea conditions. With Sir Archibald Ross, he regretted that thrust measurements had not been taken. Thrust measurements gave the only figures with which the shipowner had any concern. All other measurements, such as the torque and the indicated horse-power, were purely engineering matters. Dealing with Mr. Narbeth's criticism of the ship's performance, he said that at the time of her trials the Cape York had been four months out of dock, and that her bottom was not clean. Had the fouling been absent, better speeds would undoubtedly have been obtained, and at higher speeds the performance of the propellers would have appeared to greater advantage. Speaking generally, he said that in recent years we had had several instances of the wrong type of engine being put into ships. The engineers on the strength of such figures as those given in the report decided what type of engines should be used, and then asked the naval architects to find a vessel for them. Trouble frequently followed, as, for example, when high-revolution engines were placed in a vessel of full form.

Table V.—*Sea Trials of the T.S.M.V. Cape York.*

Nominal r.p.m. of engines	125								108				88				63				125		108	
Run number	1		2		3		4		5		6		7		8		9		10		11		12	
Ship's speed, knots	11·39		10·81		11·29		10·65		10·27		9·65		8·78		7·73		6·67		5·37		11·10		9·70	
Mean of means or mean for runs, knots	11·04								9·96				8·26				6·02				11·10		9·70	
Engine speed, r.p.m.	P 122·9	S 126·5	P 120·5	S 119·8	P 123·1	S 120·8	P 120·0	S 122·2	P 109·0	S 107·6	P 110·6	S 110·1	P 90·3	S 83·0	P 90·2	S 88·3	P 64·3	S 64·9	P 63·4	S 63·7	P 120·8	S 124·3	P 106·4	S 106·6
Mean indicated pressure, lb. per sq. in.—Average	114	111	118	101	119	104	120	106	102	88	104	91	78	70	85	69	56	51	59	44	113	110	99	86
Port engine—																								
Indicated horse-power	1,590		1,615		1,665		1,640		1,260		1,310		800		870		410		425		1,550		1,200	
Mechanical efficiency, per cent.	68·5		69·0		69·5		69·6		66·2		66·6		61·4		62·8		53·4		54·7		68·4		65·6	
"Brake" horse-power	1,090		1,113		1,157		1,140		836		870		491		545		219		232		1,060		785	
Corresponding torque, lb.-ft.	46,600		48,600		49,300		49,900		40,200		41,300		28,500		31,700		17,900		19,200		46,100		38,700	
Torque, mean of means or mean for runs, lb.-ft.	48,800								40,750				30,100				18,550				46,100		38,700	
Starboard engine—																								
Indicated horse-power	1,595		1,375		1,430		1,470		1,075		1,140		600		600		375		320		1,555		1,040	
Mechanical efficiency, per cent.	68·0		66·0		66·6		67·0		63·4		64·0		59·5		59·2		49·6		44·0		67·8		63·0	
"Brake" horse-power	1,084		910		952		985		682		730		393		410		186		140		1,055		655	
Corresponding torque, lb.-ft.	45,000		39,900		41,400		42,300		33,300		34,800		24,900		24,400		15,050		11,550		44,600		32,300	
Torque, mean of means or mean for runs, lb.-ft.	41,400								34,050				24,650				13,300				44,600		32,300	
Total fuel per hour to main engines, lb.	1,063		976		998		976		673		724		—		433		228		198		968		642	
Port engine—																								
Torsionmeter observations:																								
Torque, mean of means or mean for runs, lb.-ft.	49,510								40,490				25,170				13,500				50,000		42,700	

The report was presented last Friday by Mr. C. W. J. Taffs, the secretary to the Committee. In the course of his remarks, Mr. Taffs intimated that in due course a paper correlating the results of all the five trials that had now been completed would be presented to the Institutions by Professor W. E. Dalby. Commenting on the performance of the Cape York, Mr. Taffs remarked that the mechanical efficiency of her engines as revealed by the shore trials was somewhat lower than might have been expected, but its lowness was perhaps not surprising in view of the number of pumps which the engines had to drive. During the sea trials the vessel was trimmed 8ft. down at the stern, and this fact undoubtedly affected the test results by causing the flow of fuel to the after cylinders to be excessive. The "Ford" torsionmeter was found to give very consistent results. The manœuvring trials showed that the manœuvring equipment was ample for its purpose, all the tests imposed by the Committee being fully met.

Sir Archibald Ross was called upon by the President to open the discussion. Sir Archibald, in the course of his remarks, said that as usual the logs at sea showed a better performance than that given during the trials. The Cape York had just returned from a 30,000-mile voyage. Her logs showed that fully loaded with a displacement of 12,540 tons she had accomplished a speed of 9·4 knots on the average for a consumption of 7·22 tons of fuel oil per day. That figure would possibly have been still better had bronze instead of cast iron propellers been fitted. From the naval architects' point of view, it was regrettable that trustworthy records of the thrust developed were not available for all the trials. There was still difficulty in determining the indicated horse-power of marine oil engines on a trustworthy basis. Even with the best indicators fair-sized errors were probable. On the Cape York the indicators undoubtedly gave results that were too high and therefore caused the mechanical efficiency to appear unduly low. That the indicators gave high results was confirmed by a study of the thermal efficiencies deduced from the test results. These efficiencies, Sir Archibald said, appeared to be too high, too near the ideal, to be true.

Mr. J. H. Narbeth said that the Werkspoor engine was a sound and substantial design, and was in considerable favour, particularly among continental nations. Its balancing was good and its lubricating oil consumption was low. Its mechanical efficiency, however, was exceedingly low. The figures given in the report were, in fact, startling as compared with the mechanical efficiencies recorded in the preceding four reports. They were so low that in order to account for the popularity of the design, he could only conclude that the engine possessed some excellent feature that was not brought out in the report. During the full-speed sea trial the engines ran at the rated speed of 125 revolutions per minute, and developed more than their rated power. Yet the ship's speed was just the designed speed, in spite of the fact that her displacement during the trials was only 5610 tons, as compared with the designed fully loaded displacement of 12,465 tons. Comparing the fuel consumptions per brake horse-power per hour of the five vessels tested by the Committee, he represented that of the Scott-Still engined vessel Dolius by 100 in each case, and got the following results for full and low power :—

Engines.	Full-power.	Low-power.	Percentage difference.
Scott-Still	100	100	50
Doxford	112	96	25
Fullagar	117	117	50
Richardsons-Tosi	120	135	70
Werkspoor	124	147	80

The change in the consumption between full and low-power in the case of the Werkspoor engines suggested that there was a great deal the matter with the ship's propellers. New propellers, he suggested, would give much better consumption figures.

Mr. Thomas Clarkson expressed surprise that on the Cape York, so far as the report showed, no steps were taken to recover the large amount of heat escaping in the exhaust gases. It was well known that in internal combustion engines generally, more heat escaped in the exhaust than was converted into work. The auxiliary boiler on an oil-engined vessel probably consumed about a ton of oil fuel per day. The whole of that consumption could be saved by the proper utilisation of the heat in the exhaust gases. Mr. Clarkson then showed a number of lantern slides illustrating the development of the Clarkson thimble-tube waste heat and donkey boiler. These boilers, of which we illustrated an example in our Olympia Exhibition Supplement of November 20th, 1925, as fitted on board the motor vessel Malabar, can be arranged with auxiliary oil burners for use when no exhaust gas is available, and with deflectors which permit the gases to be passed either through the boiler or direct to the silencer. A particular example which Mr. Clarkson described is fitted with a sleeve valve, which by-passes some or all of the gases in order that the steam production may be regulated to the requirements without having to blow off the excess. Mr. Clarkson stated that these thimble tube boilers might without harm be run dry, and that no indication had ever been received that they were responsible for any increase in the back pressure on the engine. In the case of some two-stroke cycle engines, it had been found that the addition of the boiler actually decreased the consumption of fuel oil at the engines. The reason, he believed, was that the boiler caused a sudden contraction of the gases which facilitated their exit and reduced the back pressure.

Mr. W. A. Tookey, by means of a series of diagrams thrown on the screen, drew additional attention to the peculiarities of the indicated horse-power figures given in the report. He showed that in all cases the fifth report figures when examined on the basis of mixture strength—B.Th.U. per cubic foot of cylinder volume—were far from being in agreement with the results of a similar analysis of the figures for the preceding four vessels. The conclusion he drew was that there was some defect in the method of driving the indicator gear on the Werkspoor engines. Mr. Tookey then proceeded to outline an analytical method for defining an ideal standard of comparison for the efficiency based on the observation of the exhaust gas temperatures.

Mr. Hamilton Gibson contributed to the generally expressed belief that the indicated horse-powers recorded in the report were too high. The Admiralty coefficient for the vessel—a quantity inversely proportional to the indicated horse-power—was only 137, whereas it should be at least double that figure.

Mr. G. S. Baker, of the National Experimental Tank, Teddington, also dealt with the question of the measurement of the horse-power. The Cape York, he said, was the third vessel fitted with Werkspoor engines of which he had studied the trial results. All had shown efficiencies of the order given in the paper. He had little doubt that the indicator results were wrong, and that the Werkspoor designers were responsible for the errors. The errors were consistent, and it was evident that the method of driving the indicators was not suited to the engine.* The torque measurements were the best so far obtained by the Committee. At the high speeds the discrepancy between the observed and the calculated torques was not more than 1 or 2 per cent., and it really appeared as if at last we had obtained a torsionmeter that would stand up to sea conditions. With Sir Archibald Ross, he regretted that thrust measurements had not been taken. Thrust measurements gave the only figures with which the shipowner had any concern. All other measurements, such as the torque and the indicated horse-power, were purely engineering matters. Dealing with Mr. Narbeth's criticism of the ship's performance, he said that at the time of her trials the Cape York had been four months out of dock, and that her bottom was not clean. Had the fouling been absent, better speeds would undoubtedly have been obtained, and at higher speeds the performance of the propellers would have appeared to greater advantage. Speaking generally, he said that in recent years we had had several instances of the wrong type of engine being put into ships. The engineers on the strength of such figures as those given in the report decided what type of engines should be used, and then asked the naval architects to find a vessel for them. Trouble frequently followed, as, for example, when high-revolution engines were placed in a vessel of full form.

* It is not made specifically clear in the report how the indicators were driven during the sea trials. No diagram or drawing is given showing the rig as was done in previous reports. In the absence of information to the contrary we assume that the same method of driving the indicators was employed during the sea and the land trials. Dealing with the equipment used for the land trials, the report merely says that the indicators were of the "Maihak" external spring, oil engine type, and that they were driven by cams carried on the main cam shaft. The cam drive presumably forms a permanent part of the design.

Mr. William Still said that only once in his experience had he found indicators driven by cams off the lay shaft giving other than results that were too high. The drive was unsatisfactory, because the spring in the lay shaft caused it to revolve out of phase with the crank shaft. He then proceeded to show a series of lantern slides, which, he said, all demonstrated that errors were present in the method of driving the indicator. In one instance, he seemed to imply that the indicator cards might be as much as 17 per cent. too big. Dealing with Mr. Tookey's method of analysing the efficiency of an engine on the basis of its exhaust gas temperature, he said that while trustworthy temperatures could be obtained from four-stroke cycle engines, the exhaust gas temperatures of two-stroke engines might be determined at any value desired, simply by moving the position of the pyrometer a slight amount in the exhaust stream.

Sir Ernest Petter remarked that all the Committee's trials had been conducted on slow-speed engines. It would be a pity, he said, if the Committee concluded its labours without giving the members of the Institutions an opportunity of comparing the results obtained with those given by marine oil engines of relatively high speeds. Many marine engineers at present refused to consider an oil engine having a speed departing to any extent from the normal reciprocating steam engine speed. He believed, however, that the marine oil engine would develop towards higher revolutions. In vessels of a lighter type than those examined by the Committee, engines of higher speed were already giving good results. A great deal could be said in favour of the use of high speeds in marine oil engines. There was, for example, a great gain in carrying capacity, a gain that would more than compensate for any loss of propeller efficiency. He suggested that the Committee might arrange to test the performance of an oil-engined tug now being completed for New Zealand. This tug had engines developing 600 horse-power at 270 revolutions per minute. Two similar vessels had now been in commission for two or three years.

Mr. Narbeth, just before the President called upon Mr. Taffs to reply to the discussion, rose to say in reply to Mr. Baker's observation that the condition of the ship's bottom was not enough to account for her relatively poor performance in the lightly loaded condition. The irregularity of the test results, he added, might also be noted, that on the low-power trial—run No. 12—the starboard engine was shown as developing about 15 per cent. less horse-power than the port.

Mr. Taffs, replying to the discussion, said that comparisons of the fuel consumptions of the five vessels tested by the Committee were not quite fair, in view of the fact that the vessels were not all in the same condition of loading. The Committee had to take the vessels as they were handed to it by the builders. It was impossible to adjust the loading or trim. In particular, it was not possible to run the trials in the fully loaded condition, for to do so would interfere with the conditions of the insurance policy on the ship and her cargo. The trim of the vessel greatly affected the flow of fuel to the cylinders. If she were down by the stern, as in the case of the Cape York, the after cylinders were flooded, and the forward starved, and the exhaust gas temperatures rose from cylinder to cylinder going aft. The mechanical efficiencies used in connection with the sea trial results in the case of the Cape York, were taken from the B, or high-speed, series of land tests. As, however, the engines were overloaded, he thought it would have been fairer to have used the results given by the C, or slow-speed, land tests. The results, he thought, showed that for the pitch of the propeller the diameter was too great. A similar deduction had been drawn from the test results for the British Aviator. Six inches had subsequently been taken off the diameter of that vessel's propeller, with the result that her running had been vastly improved.

A joint meeting of the North-Western Branch and the Liverpool Engineering Society was held at the Temple, Dale-street, Liverpool, on Friday, December 10th, when Mr. S. B. Freeman, C.B.E., presented the fifth report of the Marine Engine Trials Committee.

The discussion was opened by Professor Watkinson, who said he thought it was unfortunate that no criticism and no analysis of any of the results were given in the report. The results were very disconcerting in many respects. The outstanding feature was the apparent low mechanical efficiency of the engine, i.e., in the neighbourhood of 66 per cent. He thought the reason for that was that the indicated horse-power was far too high. Some of the indicator diagrams were similar to those of an explosion engine and not those of the Diesel type. On the other hand, other diagrams were much more like Diesel diagrams. The marked difference was between the diagrams taken when using boiler and Diesel oil. He had been working out some of the data in connection with the two tests Nos. 10 and 14, both at the same speed, one with Diesel and the other with boiler oil, and he found that with Diesel oil the brake horse-power was 1018 and the indicated horse-power 1530, while with boiler oil the brake horse-power was 1010 and the indicated horse-power 1420. Professor Watkinson thought the inertia effect of the explosion accounted for the recorded indicated horse-power being higher than the true indicated horse-power. The mechanical efficiency in the first case was ·661 and in the second case ·712, and the latter was more nearly the truth. The friction horse-power in the first case was 444 and in the second 336 for the same load. The oil consumption per brake horse-power was ·422 in the one case and ·44 in the other. The oil per indicated horse-power hour in the first case was ·28, which was too low owing to the indicated horse-power being too high. Referring to the results given on page 42 of the paper, Professor Watkinson said the curves showed that at normal full load the friction horse-power was three times what it was at full load.

Professor Scholes also spoke on the mechanical efficiency. He said that if the friction was as high as stated the wear and tear would be enormous. He asked whether the arrangement of the cranks on the crank shaft was not unusual for a six-cylinder engine. It was much more customary to have the cranks of cylinders 1 and 6 in line. With respect to the indicator diagrams, it was not the function of the designer of an oil engine to produce a flat-topped Diesel diagram. Humping the diagram on the top would lead to a more economical use of the fuel. Professor Scholes asked what the state of affairs was in the distribution boxes of the oil feeding arrangements. Was there free oil present or did the oil merely go through the boxes in the nature of a "bird of passage." He had noticed that most of the instruments had been calibrated. Were the indicators also calibrated?

Engineer-Captain W. J. Willett Bruce said he was somewhat overwhelmed by the number of auxiliaries which were driven off the main engine. He asked what power was absorbed by them. He was struck with the tabulated figures for the weight of the machinery; 608 tons seemed to be very low. He noticed that the cooling was done by salt water. He was under the impression, owing to experience gained in recent years, that it was better to use fresh water to prevent incrustation.

Mr. G. E. E. Burgess thought the arrangement of the cranks would not give as good a balance as the ordinary arrangement. He would like to know whether anything had been noticeable in that connection. He would also like more information about the fuel arrangements. It seemed to him that it was quite possible for fuel to get back through the connections shown if the two valves were left open. On submarine engines there was a control which allowed the moment of admission to be varied. It was noticeable sometimes that if this control were set too early very high mean pressures were indicated, although the brake horse-power was not altered at all. By bringing the control back a little to give later admission the indicator curves were reduced even as much as from 120 lb. to 100 lb. per square inch.

After one or two other speakers had made some observations with regard to the jacket water and the utilisation of the heat lost therein, Mr. Freeman replied to the discussion. With regard to the method of making the report, he said the observers had done all they were asked to do. When the reports were all co-ordinated they would be able to compare the results of the different engines. With regard to the tests, the consumption per brake horse-power was about the same for all; it was the indicated horse-power that varied so much. The low mechanical efficiency was the thing that first struck him, but the fuel consumption per indicated horse-power was comparatively low. He went on to refer to the piston rings. On the first run the rings had seized and given trouble and had had to be taken out and eased so that they would float easily. Both notched and plain rings had been tried, but he did not think one had come out better than the other. It seemed to be fairly good practice to "locate" the top two rings and allow the lower rings to float. The fuel valves were set on the centre line of the cylinders. The oil fuel pump was of the constant-stroke type, and he believed there was an overflow arrangement. The usual arrangement was to have a separate pump for each cylinder. The springs of the indicators had been calibrated. With regard to lubricating oil consumption there was no figure given, but on an engine of the same type, but double the power, his company had some experience and the consumption was about 4 gallons per day. Answering one of the speakers with regard to the disposition of the cranks, Mr. Freeman said the arrangement was adopted to secure good balancing. In connection with the use of salt water for cooling purposes, Mr. Freeman said that it had done well on the whole and there was no trouble if the surfaces were not too hot and the water was kept in active motion.

The annual dinner of the Institution was held on the preceding evening, Thursday, December 9th, at the Connaught Rooms. The President, Mr. William Reavell, was in the chair, and the gathering of members and their guests was a large one.

After the loyal toasts had been given by the President and musically honoured, the toast of "The Progress of Engineering" was proposed by Major-General H. F. Thuillier, Director of Fortifications, War Office, and President of the Institution of Royal Engineers. It was replied to by Sir Henry Fowler. In an able speech, which at once revealed the engineer as well as the politician, Lieut.-Colonel J. T. C. Moore-Brabazon, Parliamentary Secretary, Ministry of Transport, gave the toast of "The Institution of Mechanical Engineers," to which the President responded. We make some reference to Mr. William Reavell's remarks in one of to-day's leading articles.

Mr. Loughnan Pendred introduced a characteristic note of humour into his speech welcoming "The Visitors," which toast was fittingly replied to by Mr. Frederick Palmer, President of the Institution of Civil Engineers, and Dr. W. H. Eccles, President of the Institution of Electrical Engineers.

The evening was a most enjoyable one, and the speeches were without exception particularly good. During the course of dinner a programme of music was given by musicians from the Band of H.M. Grenadier Guards.

SIXTY YEARS AGO.

THE Smithfield Club Show of sixty years ago afforded us an opportunity of publishing in our issue of December 14th, 1866, a long and ardent defence of the character of the British agricultural engineer. In certain professional circles, it seems, it was then the fashion to regard the agricultural engineer with contempt, to think of him as bucolic in all his tastes, slow to receive impressions or to eliminate ideas from his heavy brain. He was considered not as a member of a great professional body, but as something not wholly a farmer nor yet quite a tradesman. His ways were not the ways of engineers. He was intelligent enough to deal with country gentlemen and clowns, to hunt up orders at market dinners and to feel highly honoured by winning a prize from some local agricultural society scarcely known outside a radius of 20 miles. But to devise means of executing simple operations such as turning a sod, distributing a little corn, cutting down a standing crop and beating the seed out of the ear, did not, in the opinion of some, demand great practical skill or a matured knowledge of the refinements of mechanical science. We sought to refute these opinions. No exhibition of agricultural machinery, we said, could be entered without the visitor feeling that in the works of the agricultural engineer there were displayed much skilled and careful thought and an enormous amount of practical engineering experience. The very simple objects which his implements and engines were designed to effect called for the display of more ingenuity than was required perhaps in any other branch of the mechanical arts. Each branch had to deal with a different section of Nature's laws. The civil engineer had to study the strength of girders, the coefficients of friction in the slopes of embankments, the strength of dams. The laws governing these matters were not more difficult to comprehend or more important in themselves than those which determined which way the blades of grass fell from the knife of a mowing machine or what seeds would float away with the blast from a winnowing fan and what seeds would enter the farmer's sacks. As much thought had probably been expended by such men as the Howards on the production of plough breasts with curves of least resistance as on the investigations of the laws of resistance of floating bodies. We were indeed disposed to think that the curves of a good plough breast were more elegant than Mr. Scott Russell's wave line. The history of the steam plough, when it came to be written, would, we suggested, be scarcely less interesting than the history of the locomotive. The position and character of the agricultural engineer, far from being in consonance with the opinions of some, was, we wrote, creditable in itself and had been creditably won. He was gradually enforcing respect from the great body of which he was a member by right of his intellect and knowledge. The representative British agricultural engineers of the day had done fully as much to elevate their particular art as the Stephensons or Brunels of a different section of the same great brotherhood. After this spirited defence of the agricultural engineer it is somewhat disconcerting to find that we immediately proceeded to castigate him in general terms for failing to show on the average either originality or energy and in certain cases for displaying workmanship nearly as bad as it could possibly be. While we have no longer any need to defend the status of the agricultural engineer, we have still occasion, as in last week's issue, to complain of the similarity in the exhibits staged year after year at Islington.

NATIONAL CERTIFICATES IN NAVAL ARCHITECTURE.—The Institution of Naval Architects and the Worshipful Company of Shipwrights in conjunction with the Board of Education are prepared to approve schemes submitted by technical schools or colleges for the award of certificates in respect of part-time grouped courses under approved conditions. For the purpose of administering the award of these certificates, a National Certificates Committee, consisting of representatives of the Institution of Naval Architects, the Worshipful Company of Shipwrights, and the Board of Education will be formed. Before a scheme is approved, the Committee will require to be satisfied, for the purposes of the courses under the scheme, as to the equipment of the school, the qualifications of the staff, the curriculum and syllabuses of instruction in the several subjects, and the steps to be taken to secure that students are not admitted to the courses unless they are qualified to profit by them. For the present, certificates may be issued in respect of courses taken by students who have not completely fulfilled the prescribed conditions, provided that the conditions are fulfilled in regard to the last year of the course. It will be a condition of approval of a scheme that certificates shall be issued only to those candidates who pass the prescribed examinations. In order to satisfy the Committee in respect both of the standard of the questions set and of the marking of the examination papers for the certificates, the Committee will appoint assessors who will act under the control of the Committee. The assessors will revise the examination papers set at the end of the final year of each course, and will have the option of substituting questions up to 40 per cent. of the total number of questions set and may make any questions compulsory, provided that the number made compulsory shall not exceed about 40 per cent. of the number to be answered. The Worshipful Company of Shipwrights will offer for competition each year, among students obtaining higher certificates, a gold, silver and bronze medal. The examinations for this competition will be separate from and in addition to any examinations set for the higher certificates. Candidates will be selected from those nominated by the principals of their technical colleges or schools. Conditions of the award may be obtained from the clerk to the Worshipful Company of Shipwrights.

Indian Engineering Notes.

(*From an Indian Correspondent.*)

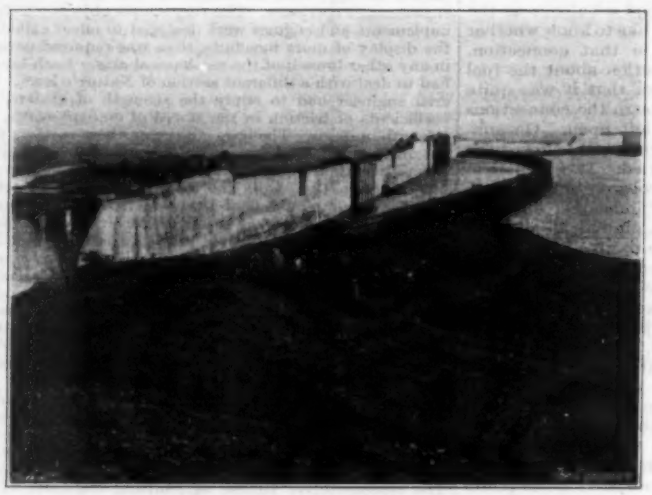
Irrigation in Bombay.

THE magnitude and results of major irrigation works in the Bombay Deccan—the great plateau of Western India, which, though quite close to the Western Ghats, is yet peculiarly liable to famine—are not always realised in this country. In the past half-century they have converted areas which were subject to frequent droughts into fertile tracks producing magnificent crops, and benefiting the country and its people enormously. Two of the largest irrigation schemes in the world have recently been completed in the Deccan. The first is the Nira Canals extension, in connection with which the Lloyd Dam at Batghar has been constructed. This vast structure is 190ft. high, 5333ft. long, and it holds up 24,000 million cubic feet of water in a lake with an area of 15,000 square miles. It is claimed to be the largest dam in the world, and the amount of masonry in it exceeds by three million cubic feet that contained in the Assouan Dam. The total area commanded by the Nira Right Bank and the Nira Left Bank canals is 900,000 acres. The other scheme embodies the Pravara Right and Left Bank canals, with storage at Bhandardara. There has been constructed a dam 270ft. high—twice as high as the Nelson Monument—and 1600ft. long, which impounds 13,000 million cubic feet of water and commanding an area of 183,000 acres. Both these great schemes were designed and have been carried out by the Bombay Public Works Department. Irrigation from the extensive lakes formed by these dams—some views of which are given herewith—is rapidly being developed in the valleys below them. In the Pravara area irrigation has grown very rapidly, and where before hardly any crops could be grown its lands are now covered with valuable sugar-cane crops.

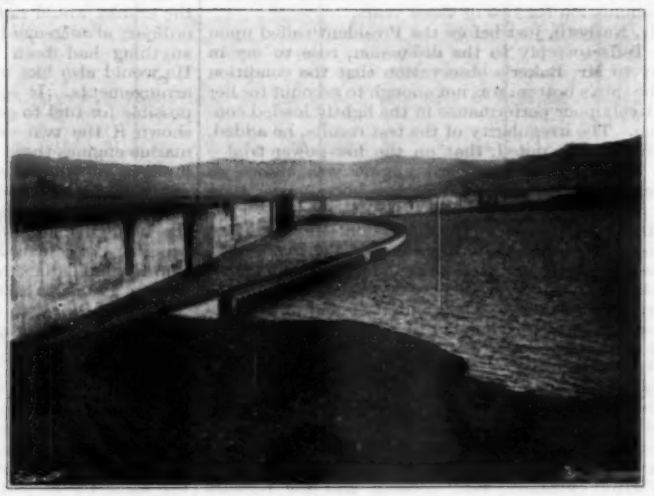
Eleven years ago the total area commanded and protected by canals in the Deccan amounted to only about nine lakhs of acres, whereas when the schemes now in hand are completed and fully developed, the total area will amount to about sixteen lakhs of acres. During the same period the area irrigated annually has arisen from just over one lakh of acres to nearly two lakhs and forty thousand acres, and the total value of the crops raised has shown a much greater increase. The value of crops grown on the canals eleven years ago was estimated at one crore and fourteen lakhs of rupees a year; whereas the latest figures estimate their annual value now at nearly four crores of rupees. These figures show what a great increase in prosperity irrigation has already brought to the Bombay Deccan.

LLOYD DAM FOUNDATION TRENCH, OLD DAM ON RIGHT, 1915

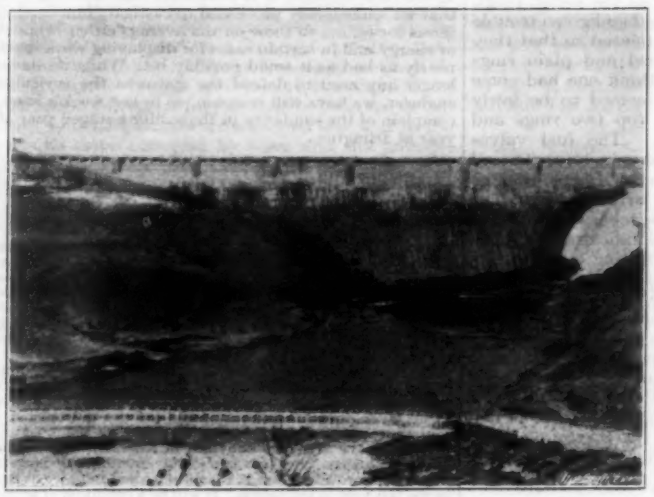
LLOYD DAM, CONDITION IN 1923



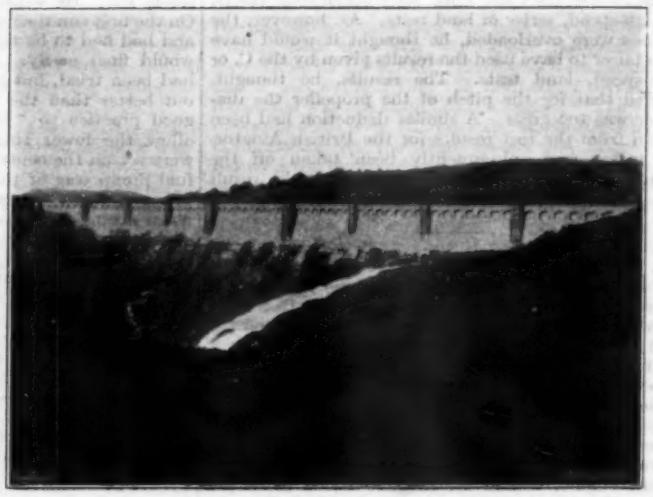
LLOYD DAM, CONDITION IN 1924



LLOYD DAM NEARLY COMPLETED, 1926



BHANDARDARA DAM



BHANDARDARA DAM

Bombay Port Equipment.

According to the administration report of the Bombay Port Trust for the year 1925–26, the total receipts during the year amounted to Rs. 284 lakhs, and the total expenditure to Rs. 277 lakhs, resulting in a surplus of Rs. 7 lakhs. The total tonnage of cargoes dealt with during the year at the docks and bunders was 6,460,000 tons, an outstanding feature of the trade during the year being a record increase in the importations of petrol, which amounted to 7¼ million gallons. Expenditure on capital works, though curtailed, amounted to Rs. 42 lakhs during the year, of which about Rs. 17½ lakhs were spent in connection with improvements to Alexandra and Hughes docks. The deepening of the entrance channel to 28ft. below L.O.S.T. and of the mail berth to 32ft. is proceeding satisfactorily according to programme. The total quantity dredged during the year amounted to the record figure of 9·1 million tons. The total expenditure on dredging was Rs. 16 lakhs. The installation of Marconi wireless sets

at the Port Signal Station and the Prongs and Kennery lighthouses, and on the steam pilot vessel was completed during the year. As the wireless communication is liable to interruption from atmospheric and other causes, an electric projector at the Port Signal Station, a gas projector at the Kennery Lighthouse, and an "Aldis" flashing lamp at the Prongs Lighthouse have been installed, supplemented by heliographs for use by day as a secondary means of communication.

Rangoon Port Development.

Proposals for developing additional and improving existing facilities for shipping and traffic within the Port of Rangoon have now been finally sanctioned by the Port Commissioners. The total cost of these works is estimated to amount to Rs. 3 crores, and will be spread over ten years, during which the works will be carried out. These works comprise mainly :—

(1) Wharves for sea-going vessels. This scheme provides for joining up Latter-street and Sule Pagoda wharves and extending the latter eastwards ; building transit and storage sheds, installing additional cranes, railway sidings, trolley lines and other equipment, and carrying out necessary alterations in the lay-out of the existing wharves, enclosures, &c.

(2) Facilities for inland vessels traffic at Lamadaw :—The scheme provides for creating a new and advanced line for foreshore between the Ywathit Creek on the west and Latter-street Wharf on the east ; erecting pontoon and fixed jetties along the new line of foreshore ; building transit sheds and go-downs to be served both by rail and road ; and remodelling railway sidings, &c.

Among other schemes are included a new Import Salt Depôt at Pazundaung, development of Dawbon Estate, moorings for sea-going vessels, and facilities for inland vessels traffic at Botataung.

The Port of Calcutta.

The results of the working of the Calcutta Port Trust for the year 1925–26 show a total income of Rs. 321 lakhs and a total expenditure of Rs. 290 lakhs. The total tonnage of imports and exports amounted to 7,561,000 tons, an increase of 4 per cent. over the tonnage of the preceding year. Steady progress was made during the year in the construction of King George's Docks, and the work was kept well up to schedule. The expenditure during the year thereon amounted to Rs. 157 lakhs. The amount expended on the new 80ft. lock entrance, Kidderpore Docks, was Rs. 33 lakhs. It has been decided to lay out the new marshalling yard to the west of the Diamond Harbour Road, which will set free for development a large area of valuable land between Diamond Harbour-road and Tolly's Nullah.

Contrary to general expectations, the importation of unwrought and structural steel did not show any decrease during the year on account of the protective tariff, while large quantities of iron and sheeting machinery were again handled.

ON July 22nd last a light engine left Newcastle Station immediately after a passenger train, and, according to the signalman's version, the driver was warned by the aspect of the fixed signal of the condition of the section. The latter maintained, however, that he had a "clear" signal, and therefore proceeded. As it happened, the lever in Gateshead Junction that works the distant signal had a mechanical defect, and could not be restored behind the passenger train, and as the interlocking compels the distant lever to be restored before the home signal can be put to "danger," both distant and home signals were at "clear" when the driver of the light engine sighted them, even although the passenger train was in the station. As a consequence, there was a collision, as to which Major Hall has recently reported. He recommends that the relative signal at Newcastle be so controlled by track circuit that, when the section is occupied, a warning signal is the only possible indication, and that replacers be fixed on the signals in this particular section to ensure that they go to "danger" as soon as a train has passed.

Power from the Tides.

A PROJECT which is on foot for the development of cheap electrical power from the tides in the estuary of the river Exe was recently discussed by the Exmouth Rotary Club, when Mr. E. L. Fleming, who is one of its leading advocates, explained the present position of the proposal. Among those present was Mr. Mann, the local manager of the Electricity Supply Corporation.

Mr. Fleming stated that since public attention was first drawn to the matter some time ago the formation of a company had been suggested by Major-General Hunt, of Sid Abbey, Salcombe Regis, who stated that he would be willing to put up £100 as the contribution of the Parish of Salcombe Regis towards the preliminary expenses, and further suggested that transmission cables be laid for the supply of Budleigh Salterton, Newton Poppleford, Sidford, Sidbury, Salcombe Regis, Branscombe, Beer, Ottery St. Mary, Honiton, Colyton and Lympstone. Mr. Fleming said that he had communicated with the Port of Exeter Authority and had received a reply from the town clerk of Exeter that the request for the City Council's permission for the placing of turbines in the bed of the river Exe would be placed before the next meeting of the Navigation Committee. The Board of Trade, in reply to a request for consent to the mooring of a vessel in the river Exe for the purpose of generating electric current, asked for a 25in. Ordnance map with the proposed site for the mooring of the vessel marked, and inquired what arrangements were proposed for transmitting the current to the adjoining property above high-water mark, and for the names and addresses of the owners of such property situated immediately opposite the proposed site for the vessel.

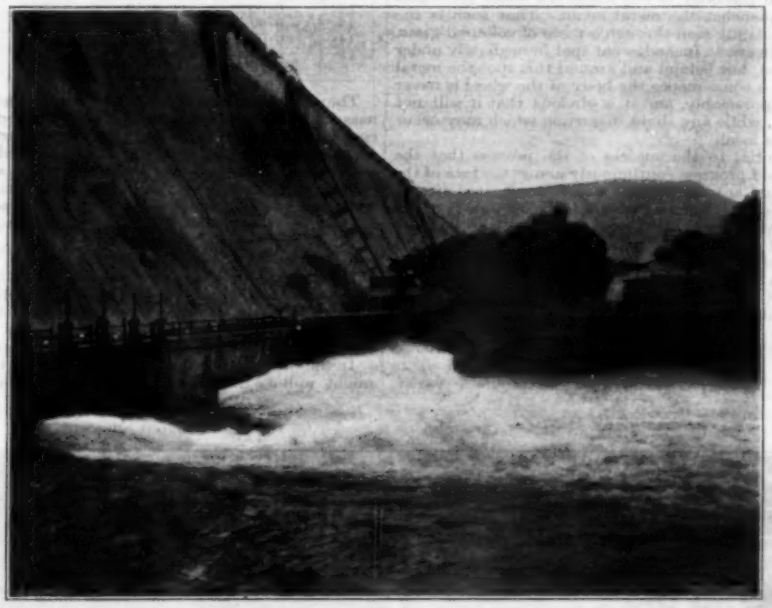
It was further explained that a letter had been written to the Electricity Commissioners in the following terms :—"At Exmouth we have a channel 400 yards wide through which the tide passes in the estuary of the Exe, covering an area of 600 acres, 4ft. deep, or 30 million tons of water flowing in and out every six hours, causing a current of from three to six knots, which turns the paddle wheels or the propellers of various craft moored in the flow of the channel. Have any investigations been made to utilise this power for the development of a cheap source of electricity ? A barrage a mile long, from Longstone Rock at Dawlish to within 400 yards of Exmouth Pier, causes this current, by reducing the width of the mouth of the Exe from 1¼ miles to a quarter of a mile. I shall be pleased to make any local inquiries or obtain any information you desire about the matter. Has this power been used in any other place in the world similarly situated to Exmouth, and with what results ?"

A reply had been received from the Electricity Commissioners to the effect that the question of tidal power was investigated in some detail by the Water Power Resources Committee appointed by the Board of Trade in 1918, the conclusions and recommendations of that Committee being embodied in its third interim report published by the Stationery Office in 1920. The Committee pointed out that the difficulties which had to be overcome in harnessing the tides were so bound up with local conditions that it was essential for the general question to be approached with reference to the actual conditions obtaining in some particular locality. The Committee recommended that a Technical Commission should be set up to investigate the possibility, from a commercial standpoint, of utilising the tides for power purposes, with special reference to the Severn Estuary, where the conditions were such as to provide an exceptionally high rise and fall of the spring tides, namely, of the order of 40ft. to 50ft. This matter had formed the subject of subsequent investigations on behalf of the Government, and the Commissioners understood that a marine survey of the country from the standpoint in question was now in course of being carried out. Although experimental efforts in respect of this problem had been made in other countries the Commissioners were not aware of any installation at which it had been demonstrated beyond question that the harnessing of the tides for the production of electricity on a large scale was an economic commercial project.

Mr. Fleming added that since the receipt of this letter from the Electricity Commissioners a local Technical Committee had been appointed, which had decided to take the advice of one of the foremost civil engineers in the country, and a gentleman who knew the mouth of the Exe and who was now considering the matter. A number of those who were taking an active interest in this matter were willing to subscribe to a fund for investigating the possibilities actually existing at Exmouth. The members of the Technical Committee, although they considered it possible to drive a dynamo from paddle wheels or propellers, thought they would like to take into counsel an engineer who was a specialist in the subject. A great deal, therefore, depended on the opinion of the specialist.

It was mentioned that a report from the eminent specialist would cost probably something like 250 guineas, but it was remarked that that would be a small price to pay for the possibility of reducing the cost of electricity to a very low figure. Mr. Fleming, commenting upon suggestions that the cost might work out at a penny a unit, said that he would not commit himself to any statement that the cost would be so low as that.

In proposing a vote of thanks to Mr. Fleming, Mr. Mann remarked that it would be far from the ideas of the Electricity Supply Corporation to oppose such a scheme, as, if it was enabled to get a bulk supply cheaper than it could generate at present, there would be no point in generating on existing lines. Doubtless there was a tremendous power in the tides, but it was doubtful whether it was a commercial proposition to reclaim that power, and that was a matter for experts to decide. He added, however, that distribution charges would account for a greater sum than a penny per unit, and said that there was a possibility that the capital necessary for such a project would be out of all proportion to the possible revenue. An expensive feature of the scheme would be the batteries to store the current generated until it was required.



LLOYD DAM, SLUICES AND DISPERSER IN ACTION, 1926

Surface-hardened Gear Teeth.

THE efforts which are being made by engineers to improve the qualities of toothed gear wheels with the objects of increasing their life, reducing their dimensions, and making them more silent, may be gauged by the fact that one firm alone in Birmingham is grinding as many as 15,000 wheels a month in order to eliminate the inaccuracies caused by the hardening process. Hardening is, of course, necessary to enable materials to stand up to the stresses demanded by modern practice, such, for instance, as the 3000 lb. per inch of tooth commonly adopted in motor car gear-boxes. It is this hardening which causes most of the trouble in producing a perfect gear wheel, as, however accurately the machinist may cut the teeth, the teeth are almost invariably distorted in the hardening processes, and it consequently becomes necessary to grind them subsequently to remove the distortion.

It seems, however, that there is every prospect of the grinding operation being at least minimised, while other advantages are incidentally secured by the use of a new system of hardening, known as the Shorter process, developed by the Patent Gear Hardening Company, of 69, Horseferry-road, Westminster, which we recently saw in operation at the works of the British Oxygen Company.

Briefly described, the process consists in intensely heating each tooth locally with an acetylene blow-pipe and immediately cooling it again with a copious supply of water. The result is a layer of hardened steel on the wearing part of the tooth, while the interior is left in its tough normal condition, as shown in Fig. 1, which is reproduced from an untouched photomicrograph with a magnification of about four diameters of half a tooth cut from a hardened gear wheel. It will be noticed that the greatest depth of hardening is at about the pitch line, and that the effect tapers away in either direction, while the hardening does not extend to the radius at the root of the tooth. This latter feature, in itself, is of considerable value, as it has been found that with a wheel hardened *en bloc* the slightest scratch or tool mark at the root of the tooth is liable to develop into a crack, which may result in the complete fracture of the tooth. The merit of the soft core to the tooth needs no comment.

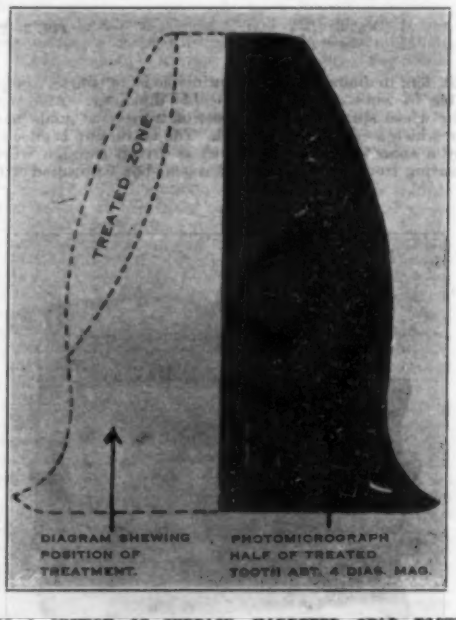


FIG. 1—SECTION OF SURFACE-HARDENED GEAR TOOTH

It might be thought that the drastic treatment in the

process of hardening which we have outlined would result is a non-coherent layer of hard steel; but that is far from being the case, as is well demonstrated by the three photomicrographs reproduced in Fig. 2. These three represent a portion of the same tooth as that shown in Fig. 1, but to a much greater magnification, some 50 diameters. In the process of taking the photographs, which were prepared at our special request, it was virtually impossible to get a continuous panoramic view across the tooth, and it must be understood that the three sections of the illustration overlap to some extent. They show, however, most plainly that the core of the tooth (on the left) is pearlite, the gradual transition into sorbite (in the centre) and the final transition to martensite towards the surface of the tooth (on the right). A study of these sections will reveal the fact that there is little likelihood of the hard surface flaking off the body of the tooth, as the transition from one stage of hardness to another is gradual and there is no distinct line of parting.

The fact that such is the case is borne out by the state of the pinion illustrated in Fig. 3. This pinion, which had been hardened by the process under review, was put in service on one of the motors of a London electric tramcar, but had to be taken off again as a bolt or some other loose piece had dropped in between the meshes and had, as will be seen, badly scored the teeth. It is noteworthy, however, that not one of the teeth has been cracked away from the hub, while a large part of the material which has been displaced in making the gashes is folded back in the immediate vicinity, and indicates plainly that the ductility of the normal steel was not affected by the surface hardening process.

It may be as well now to give some account of the apparatus employed in the process and its method of application. The machine with which the hardening process is carried out, of which we give a photographic plan view in Fig. 4, comprises a water tank of a size appropriate to the gear wheels under treatment, and a mechanism for traversing the blow-pipe and the water-quenching jets across the faces of the gear teeth.

At the centre of the length of the tank there is, it will be seen, a spindle on which the gear wheel to be hardened can be mounted. This spindle is arranged near the surface of the water and is so arranged that the wheels can be readily changed as they are finished. In the case of narrow wheels, obviously, several can be mounted alongside one another on the one spindle. The machine which we inspected has a maximum capacity of 12in. in width by 2ft. 6in. in diameter, but the principle is, of course, applicable to wheels of any practicable diameter. Alongside the wheel spindle there is a set of transverse guide bars on which a carriage can travel. The traversing is effected by a coarse-pitch screw, which is driven through worm gearing from a side shaft and a gear-box connected with the little ¼ horse-power motor seen at the end of the tank. The gear-box is of the infinitely-variable friction drive type. The whole system of guide rods and carriage can be moved to and from the wheel spindle to accommodate the diameter of the gear being operated upon.

On the carriage there is mounted the blow-pipe, which is supplied with acetylene and oxygen through the flexible pipes shown. There is also, immediately in the rear of the blow-pipe, a travelling nozzle from which a strong jet of water is delivered. Other fixed nozzles project jets of water round about the tooth being hardened, while the whole wheel is immersed in the tank water up to the level of that tooth. It is noteworthy, in connection with these water supplies, that it has been found very important for them to have a steady pressure, otherwise the action of the blow-pipe is likely to be interfered with. The water is consequently supplied from an overhead tank and the level in the working tank is kept constant by an overflow to the drains. There is an indexing device for bringing each tooth of the wheel in succession into the working position and a tripping mechanism, the function of which will be described immediately.

When the wheel or wheels have been mounted on the spindle the blow-pipe is so adjusted that the cone of its flame is directed on to the pitch line of the tooth just above the water level and the water jets are set to bear on almost the same spot. The blow-pipe is provided with a pilot jet, and it is only necessary to turn on the acetylene and oxygen and to start the traversing motor to set the machine in operation. The flame then heats up the tooth round about the pitch line to a temperature above the critical point; but before the heat can be conducted to the body of the wheel the water jet comes along and quenches the metal again. That such is the case can be plainly seen through a piece of coloured glass, as there is always an incandescent spot immediately under the blow-pipe, but behind and around this spot the metal is cold. As a consequence the body of the wheel is never heated up appreciably, and it is obvious that it will not be distorted, while any slight distortion which may occur will be quite local.

It is essential to the success of the process that the heating should progress continuously across the face of the tooth and that any spot should never be reheated after it is once hardened. For this reason the blow-pipe is extinguished immediately it has traversed the width of the tooth by means of an automatic trip mechanism. At the same time the nut on the traversing screw is opened and the carriage can then be drawn back quickly by hand ready for the next tooth. It would, of course, be possible to provide an automatic return, but the hand arrangement is more simple.

When helical or skew gears are being hardened a template attached to the main framing is used to guide the blow-pipe. The rate of progress varies, according to the width and size of the teeth, from 20 to 30 linear feet per hour.

From the above account it will be seen that the process is purely mechanical and requires very little skill on the part of the operator. It is in this direction that the Shorter process must be differentiated from some other attempts to harden by means of a hand-controlled blow-pipe, which have not been very successful. The difference lies in the fact that with a blow-pipe held in the hand it is almost impossible to avoid occasionally reheating a spot already hardened, with the result that the surface is cracked and the hard skin flakes off. In the case of the Shorter hardened gears there is no indication of cracking whatever.

In order to get an authoritative statement as to the distortion produced by the process under review a pinion of fifteen teeth and 5in. pitch diameter was submitted to the National Physical Laboratory for examination, was hardened and returned for re-examination.

In the report issued by the N.P.L. it is pointed out that the accuracy of the pinion before it was hardened was not good, but that the changes in inaccuracy produced in the hardening process were reasonably small, as is shown in the following table.

Tooth No.	Changes in spacing of flanks.		Changes in pitch of flanks.	
	Left flank.	Right flank.	Left flank.	Right flank.
	Inches.	Inches.	Inches.	Inches.
1	0·0000	0·0000	0·0000	+0·0009
2	−0·0004	−0·0006	−0·0004	−0·0006
3	−0·0005	−0·0003	−0·0001	+0·0003
4	−0·0008	−0·0002	−0·0003	+0·0001
5	−0·0012	−0·0009	−0·0004	−0·0007
6	−0·0006	−0·0008	+0·0006	+0·0001
7	−0·0009	−0·0010	−0·0003	−0·0002
8	−0·0009	−0·0011	0·0000	−0·0003
9	0·0000	−0·0014	+0·0009	−0·0003
10	−0·0004	−0·0014	−0·0004	0·0000
11	−0·0007	−0·0013	−0·0003	+0·0001
12	−0·0009	−0·0010	−0·0002	+0·0003
13	−0·0003	−0·0009	+0·0006	+0·0001
14	−0·0001	−0·0009	+0·0002	0·0000
15	0·0000	−0·0009	+0·0001	0·0000

The examination did not include any tests for hardness itself, but we are assured that, provided the carbon content of the steel is appropriate, any degree of hardness attainable by water quenching can be secured.

On examining the table above it will be seen that all the errors produced by the hardening process come well within the limits which have been set down for good gearing, so that if the untreated pinion had been really accurate the hardened gear could have been put directly into service with very satisfactory results. The hardening operation is not costly and can, we believe, be done for about half the cost of ordinary quenching work. Incidentally, the Shorter process enables comparatively cheap carbon steel to be used and leaves the body of the wheel in a tough condition best able to resist shock.

In the circumstances it would seem that an investigation might well be made as to the relative economic merits of:—cutting a gear wheel with the necessarily high degree of accuracy and so hardening it that it can be put directly in service; of cutting a tolerable wheel, hardening it by the new process and finishing by grinding; and of grinding out all the errors produced by common machining and quenching. The problem involves such a large number of variables that it is impossible to generalise, but the subject is one worthy of close study.

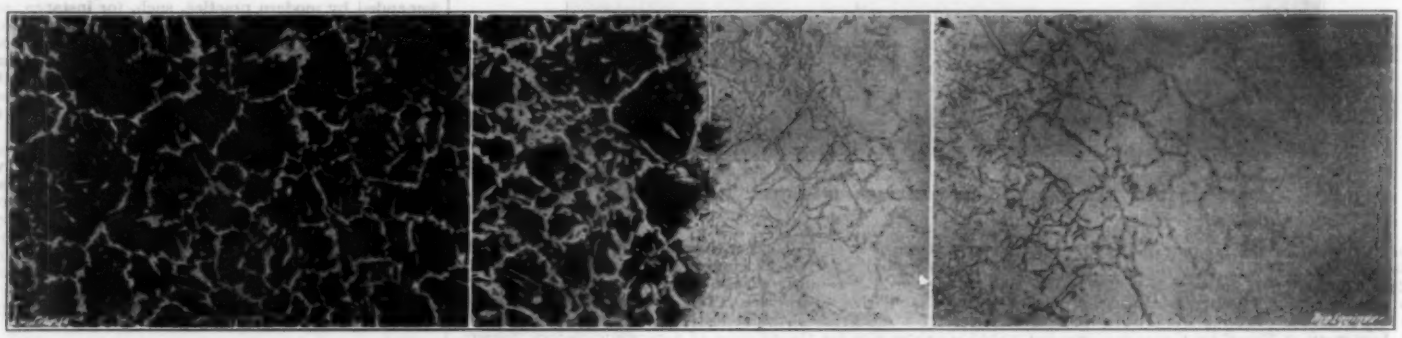


FIG. 2—PHOTOMICROGRAPHS OF SECTION OF SURFACE-HARDENED GEAR TOOTH

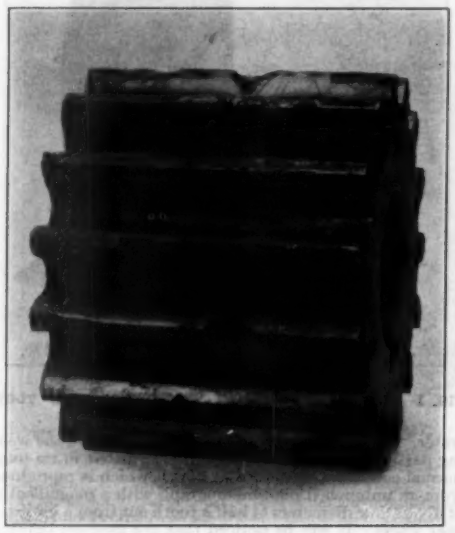


FIG. 3—SURFACE-HARDENED PINION

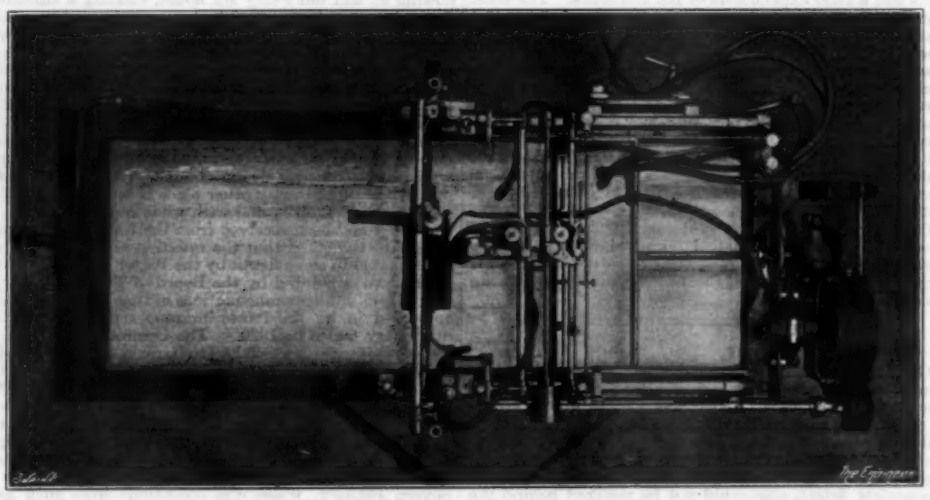


FIG. 4—SHORTER MACHINE FOR SURFACE-HARDENING

THE Sydney Water Board has approved of an expenditure of of £2,000,000 from loan money on new works for the current year.

Railway Matters.

As no parliamentary notice has been advertised by the London and North-Eastern Railway, it may be assumed that that company is not seeking any powers in next session.

THERE are general complaints as to a scarcity of wagons at the pits. That, we expect, is due to the railway companies, during the glut of idle wagons, having to put them anywhere, and now it takes time to sort them out.

ACCORDING to the answer given to a question asked on December 6th, the cost of the flying junction to be constructed at Stratford by the London and North-Eastern Railway will be £1,188,000. It is part of a scheme that will involve a total expenditure of £3,000,000.

BECAUSE of the exceptional work in the streets caused by the diversion of sewers, water, gas and electrical mains, the station buildings at Balham on the Morden Extension could not be brought into use when the new railway was inaugurated. It was opened on December 6th.

AGAIN the question of railway shopmen is on its way towards a settlement. A conference of representatives of the National Union of Railwaymen and of the other unions concerned has recently been held. At it previous difficulties were discussed and, the official report observes, "an amicable arrangement was arrived at as to future procedure."

THE last 62 chains of the Hounslow branch of the Metropolitan District Railway, *i.e.*, the length between Hounslow Central — formerly Heston-Hounslow — and Hounslow West—formerly Hounslow Barracks—were single-tracked. Moreover, they were protected by track circuit controlled signals, and not operated under any token system. That has now been changed, as the section in question has been doubled.

THE Ministry of Transport railway statistics for September, recently issued, price 2s. 6d., as a Stationery Office publication, show that, compared with the corresponding month of 1925, the number of passenger journeys was 14 per cent. less and the receipts from passenger fares 11·5 per cent. less. Passenger receipts from all sources were 10 per cent. less. The coaching miles were, however, only 5·3 per cent. fewer. The tonnage of mineral traffic fell by 72 per cent., and consequently the tonnage of freight was reduced by 51·6 per cent. Freight receipts had a decrease of 28·7 per cent. and freight mileage of 29·8 per cent.

FROM a semi-official statement issued by the railway companies, it appears that when the coal dispute began at the end of April the four grouped companies had a stock of 1,700,000 tons of British coal. Their normal requirements are 250,000 tons per week. After the first few weeks the bulk of the coal used was imported, and as it was unsuitable for locomotives working important trains, whole cargoes of coal had to be diverted to special uses and could not be distributed generally. Whilst, with careful selection, imported coal would give satisfactory results, none has been found to give the same efficiency for express train working as British coal. Owing to the indefinite nature of the dispute, it had been found necessary to make contracts for foreign coal that extended into next year, and that would compel the railway companies to use such fuel for some time to come.

A LESSON may be gathered from an accident to a driver, who, having to learn a section of road, travelled by a train which he knew would have to reduce speed through the station at the end of the section in question. In alighting from the footplate, however, he stumbled and fell between the platform and the coaches. In reporting on the accident, the Assistant Inspecting Officer said that there was no doubt that the service of trains in the district presented considerable difficulty to a man whose duty it was to make as many trips as possible. That feature should in every case be taken into consideration before a man was sent out for the purpose of learning the road. He could then be advised, if necessary, of the most suitable trains by which to travel, and the temptation to resort to irregular methods, similar to that which led up to the accident under review, would be removed.

THE failures of drawbars—which was the initial cause of the recent Rawmarsh accident—formed the subject, for the first time, of special mention in Sir John Pringle's last annual report. There were during 1925, 10,053 failures of couplings of all descriptions, of which 7655 were on goods and 2398 on passenger vehicles. In goods vehicles 1086 cases, or 14·2 per cent. of the 7655, were of simple uncoupling; 4531, or 59·2 per cent., were the pulling out or breakage of drawbars or hooks; 1924, or 25·1 per cent., were the breakage of coupling links; and 114, or 1·5 per cent., of the breakage of screw shackles. Of the 2398 failures of couplings in passenger stock, 118, or 4·9 per cent., were uncoupling; 1084, or 45·2 per cent., cases of the pulling out or breakage of drawbars or hooks; 712, or 29·6 per cent., the breakage of coupling links; and 484, or 20·3 per cent., the breakage of screw shackles.

THE annual accident bulletin of the American Interstate Commerce Commission has a new table showing the number of crossings of railways over railways and of railways over roadways. It comes as a surprise to hear that on December 31st last there were 10,154 of the former, of which no less than 4956 are not protected, *i.e.*, they have no signalling or interlocking. During the year, 171 of such crossings were dispensed with, but 118 new crossings were made. In addition, there were 4331 crossings of railways over tramways, 2421 of which were not protected. During the year 148 had been dispensed with, but 77 were added. The number of crossings of railways over highways reached the remarkable total of 233,633, of which only 27,241 were protected. There were 1776 protected and 5989 unprotected crossings eliminated during the year, but 8688 were added and only 2026 of them were protected. Of the 27,161 road level crossings protected, 3378 were guarded by barriers with gatemen always on duty, 2920 by barriers with gatemen not always on duty, 1271 had no barriers but were protected by watchmen always on duty, and 6631 by watchmen not always on duty, 5710 had audible and visible signals, 5649 had audible signals, and 1602 had visible signals.

Notes and Memoranda.

A SYNTHETIC resin with some of the characteristics of glass has been discovered by Dr. Pollak, of Jena. It is as transparent and resistant to wear as glass, but is very elastic and unsplinterable.

ACCORDING to Mr. O. J. Parker, low-temperature experimenters in most instances begin at the wrong end by working on coking coals of high volatile content, whereas they should start on low grade and non-coking kinds. Already the mineowners have a market for both large and slack coking coal, but with non-coking coals the case is different. What is needed to be done is to bring the latter up to the value of the former class of coal, and that would mean saving many of our coalfields to-day.

IT is reported from Stockholm that two new inventions of refrigerating apparatus for household purposes have been made by Swedish engineers, one by Chief Engineer Risberg at the Baltic factories, Soedertaelje, on the compression principle, the other by Engineer A. J. Munters, father of the inventor of the refrigerator manufactured by Aktiebolaget Elektrolux. The A. J. Munters invention is constructed on an entirely new principle, but patents have not yet been definitely taken out. Both inventions are said to have passed very satisfactory trials.

IN the course of a lecture to the Heriot-Watt College, Emeritus Professor Henry Louis said that the only appliance which has been used at all extensively in practice for dry-cleaning coal is the Sutton-Steele table, which is, in fact, a Wilfley table, the surface of which consists of some permeable material, whilst the table itself forms a shallow box into which air is blown. The streams of air passing through the surface of the table lift and stratify the coal, so that clean coal passes straight down the table, whilst the refuse travels along the riffles and is discharged at the end, middlings being discharged at an intermediate position.

RESEARCH work by David H. K. Bottrill, an Australian metallurgist, who is conducting a series of experiments at McGill University, Montreal, has, it is reported, resulted in a new process of welding aluminium, which is regarded as likely to be of importance in connection with electrical transmission. Hitherto breaks in aluminium transmission cables with a steel core have been repaired by the oxy-acetylene process or by arc welding. The steel core had to be repaired first, and the heavy aluminium strands then laid over the top. Mr. Bottrill claims that, by his process, Thermit can be used to do the same work in a few seconds at a trifling cost as compared with other methods. He is now engaged in perfecting the process.

A REPORT from Toronto states that Dr. Howard T. Barnes, Professor of Physics at McGill University, Montreal, who has made a speciality of ice research for thirty years, will conduct experiments on the Upper St. Lawrence to find a ray which will imitate the rays of sunlight under water and prevent the formation, and stop the growth, of anchor ice forming at the bottom of the open water. Dr. Barnes has already devised a lamp that will give out a ray to imitate the rays of sunrise, which he hopes will prove successful. The agents in producing the new ray, the nature of which has not at present been disclosed, are claimed to be more powerful than Thermit, which so far he had found to have the nearest action to that of sunlight when used on solid ice.

THE Estonian Legation in London reports that one of the most important features of the Estonian oil shale industry last year was the final adoption by the Estonian railways of oil shale as fuel, the railways thus becoming a large consumer of this fuel, in addition to those industrial enterprises already using oil shale as their sole fuel. The Government mines produced about 235,000 tons raw shale, which constituted only about 72 per cent. of the estimated programme for 1925. This was due to the fact that the commencement of work at the large new oil distilleries at Kohtla was retarded owing to delays which occurred in the erection of plant. The retorting plants were only able to start operating in the autumn of 1925, and produced about 2600 tons of fuel oil, in addition to lubricating oils, motor spirit, asphalt, &c. The State oil shale mines at the close of 1925 showed a net profit of about 15 million E.mks., as compared with 10 million E.mks. in 1924.

ACCORDING to the *Ironmonger*, some experiments are being carried out at the Lorain Works of the United States Steel Corporation on the production of a practically pure granular iron, direct from the ore and without the use of coke or limestone. Results have given a 98 per cent. pure iron. Sufficient progress has been made to warrant expectations of a material diminution in production costs, which may possibly extend to the conversion of the metal into steel. Officially, the process is described as follows:—This process is based on pre-heating, reducing and cooling iron ores in rotary kilns, in successive stages, and at a temperature low enough to prevent fusion. The process consists in crushing the ores, after which they are charged into a rotary kiln heated to a definite temperature. They are then passed into a second rotary kiln, mixed with coal, and are heated to a higher temperature, and pass thence to a third rotary kiln, where they are subjected to a sudden cooling.

IN a paper on outbursts of gas in coal mines, contributed to the South Wales Institute of Engineers, Mr. G. Roblings gave an account of two violent outbursts on the Continent. One occurred at Nord D'Alais in 1907, when after firing a volley of shots an immense cloud was thrown out of the mouth of the shaft to a height of 120ft., covering the surface for a considerable area—in fact, blackening the land for 50 to 60 acres, and an area of 650 by 800 yards was inaccessible for two hours, while three men were asphyxiated in the engine-house, and people in houses in the vicinity were partially asphyxiated, and fowls, dogs and birds were killed. It was estimated that 4000 tons of coal were projected. Another outburst occurred at Rochebelle, in 1920, and displaced 5000 metric tons of coal. The gas—carbon dioxide—came off so rapidly that five minutes after short-firing it had not only filled the galleries, but had reached the surface up the shafts in such quantities as to compel the evacuation of all houses in the neighbourhood and interrupted road traffic.

Miscellanea.

THE institution of a new Department in Highway Engineering is announced at McGill University. In future highway engineering will be one of the subjects in which a student can proceed to the Master of Science degree.

PLANS are under contemplation for the establishment of a beet sugar factory at Bassano, Alberta, where the great C.P.R. irrigation dam is situated. This would be another unit of the big factory at Raymond, which has completed its first year's operations.

NATURAL gas has been struck south of Souris, Manitoba, according to information received by the Provincial Lands Department. The strike was made while two men were engaged in drilling a well on a farm south of the town when a depth of 282ft. had been reached.

UP to the end of September the coal output of the Nova Scotia mines of the British Empire Steel Corporation nearly trebled the production for the same period last year, which was 1,362,820 tons, as compared with 3,687,795 tons to September 30th of this year.

IN his annual address to the Legislative Council of Sierra Leone on November 30th, Sir Ransford Slater, the Governor, confirmed the discovery of a substantial deposit of exceptionally high-grade hematite in the Marampa Chiefdom of the Port Lokko District, about 20 miles from the river port of that name. Sir Ransford announced that the Government would leave exploitation to private enterprise.

WORK has begun on a new hydro-electric station at Cardona, which will be the largest of its kind in Europe. Its yearly output is given as being 500,000,000 kilowatt-hours, the greater part of the current being supplied to the provinces of Lombardy and Piedmont. Hydraulic power will be obtained by the diversion of the river Isarco through a tunnel 16 kiloms. long, providing a fall of 75 m. It is planned to complete the work within two years.

DURING the year ended June 30th nearly 3000 vessels berthed at Singapore wharves, representing a tonnage of 8,000,000. The tonnage of cargo dealt with was over 3,000,000. The total revenues of the Harbour Board for the year were 11,250,000 dollars, which leaves a surplus of 1,500,000 dollars. Proposals are being considered to increase the wharfage, probably by adding ten 600ft. wharves, in order to cope with the increased traffic.

THE returns relating to the passenger traffic between the United Kingdom and places outside Europe, and not within the Mediterranean Sea, show that the number of persons of British nationality who left the United Kingdom as passengers for such countries during the nine months ended September 30th, 1926, exceeded the number who arrived as passengers from those countries by 85,222. In the corresponding periods of 1925 and 1924 outward balances of 58,580 and 53,150 respectively were recorded.

THE foreign trade of the Sudan in the first half of the current year showed a considerable increase as compared with the corresponding period of 1925, imports amounting to £E3,007,200, as against £E2,794,700 in the first half of 1925, an increase of 7·5 per cent., while exports totalled £E4,027,600 and £E2,825,200 respectively, an increase of over 40 per cent., states the *Palestine and Near East Economic Magazine*. The principal articles imported were yarns and textiles £E708,400, metals and metal ware £E535,000.

APPLICATION has been made by a Brazilian engineer, Dr. Jose Antonio da Fonseca, and Mr. Charles Keyes, representing a number of British and American capitalists, for the construction of the new port proposed for Sao Sebastiao, in the State of Sao Paulo, eighty miles north of Santos. A similar, but alternative, proposal has been put forward by Senhor da Fonseca and Mr. Keyes for port works at Angra dos Reis, in the western part of the State. This new port would also serve as a terminus for the Western Railway of Minas Geraes.

IN order to open up 3000 square miles of new trading territory and at the same time provide a shorter route to the East for the coal and other products of South-Western Saskatchewan and Southern Alberta, a double-deck road and railway bridge has been built across the South Saskatchewan River near Dunblane. The top deck carries the railway track of the Canadian National Railways, the lower deck a motor road. The bridge is 1771ft. long and is built of steel and concrete. It has ten spans, of which six are 220ft. long. Ninety-feet girders carry the railway section, and the roadway has an overhead clearance of 14ft.

IN conformity with the Italian Government's policy of assisting shipbuilding by means of subsidies, it has been decided to finance the construction of the first Italian rotor ship, which is to be of 6000 tons. The amount allocated for subsidies during 1926–27 exceeds 156,000,000 lire, compared with 38,000,000 in 1925–26 and 80,770,000 in 1924–25. While great secrecy is being maintained as to the particular yard in which the ship will be laid down, it is thought that the Monfalcone establishment at Trieste may be selected in view of its comparatively isolated position and the possibility of trials being conducted with the least publicity. Alternatively, the shipbuilding yards at Genoa may be selected.

AT a meeting of the Junior Institution of Engineers on December 10th Mr. C. E. Foster described some experiments which he had recently carried out with a pyrometer for the purpose of measuring temperatures within the cylinders of internal-combustion engines of motor car engine size. Mr. Foster said that in the ordinary cylinder heads of such engines there is no provision for the insertion of any instrument, and if any provision were specially made it would probably result in a change in the characteristic working of the engine. He had therefore devised an arrangement whereby the sparking plug was made to serve a dual function as a part of the ignition system and also as a thermocouple. The central electrode was altered so as to comprise a central core within an annular sleeve, the two parts being of different metals and being insulated from each other except at the tip or sparking point where they were welded. Wires were connected from the core and sleeve to the usual reading instrument.

COAL AND ORE SILOS AT THE OUGRÉE-MARIHAYE STEEL WORKS

DESIGNED BY PROFESSOR G. MAGNEL, OF GHENT, AND CONSTRUCTED BY MESSRS. PIEUX FRANKI, LIEGE

(*For description see page* 654)

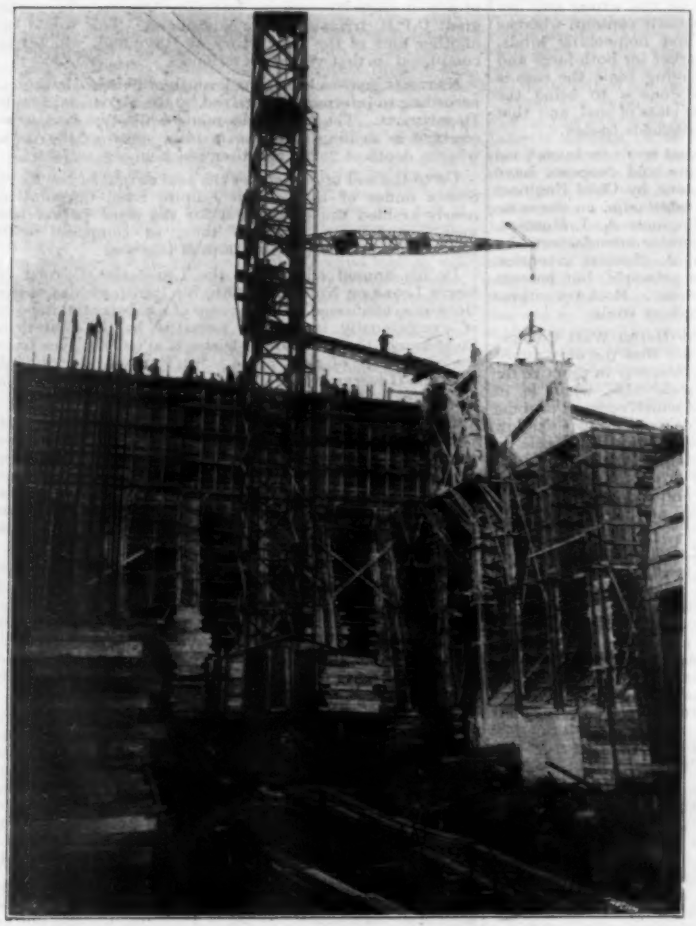


FIG. 10—CONCRETE DISTRIBUTING TOWER—FEBRUARY, 1925

FIG. 11—CORNER OF ONE OF THE ORE BINS—JULY, 1925

FIG. 12—STRUTS FOR PLATFORM OF COAL PREPARING HOUSE—JULY, 1925

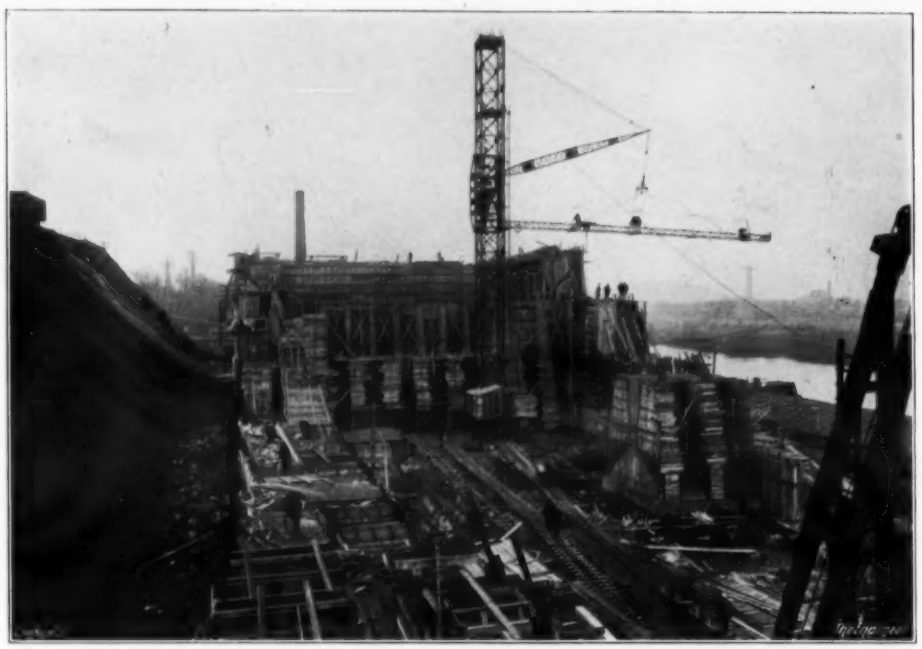
FIG. 13—FRONT OF COAL PREPARING HOUSE—SEPTEMBER, 1925

UNIV. OF MICH.

ORE AND COAL SILOS AT THE OUGRÉE-MARIHAYE STEEL WORKS

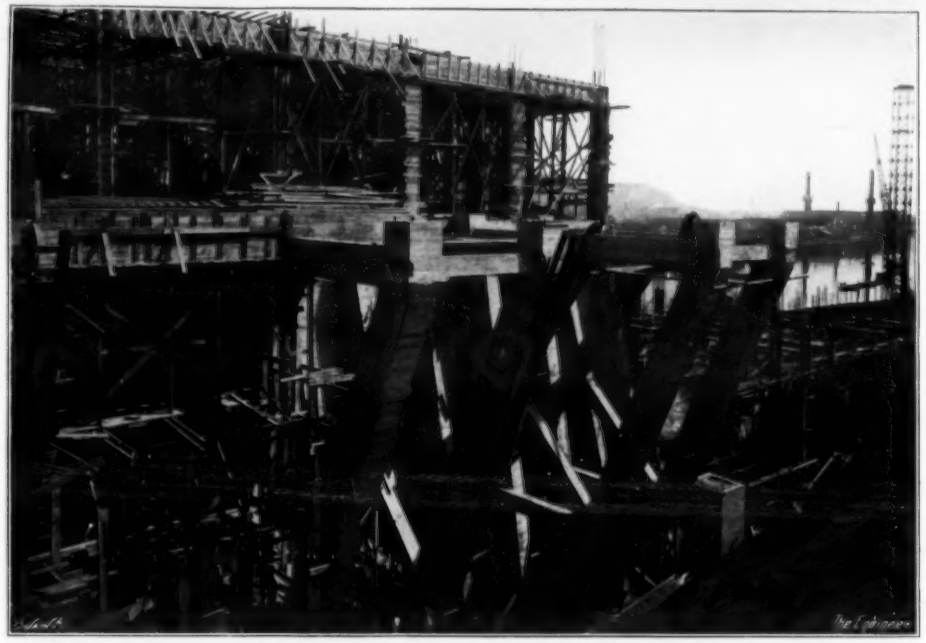
DESIGNED BY PROFESSOR G. MAGNEL, OF GHENT, AND CONSTRUCTED BY MESSRS. PIEUX FRANKI, LIEGE

NO. I.—CONSTRUCTION OF FOUNDATIONS FOR ORE AND COAL SILOS—JULY, 1924

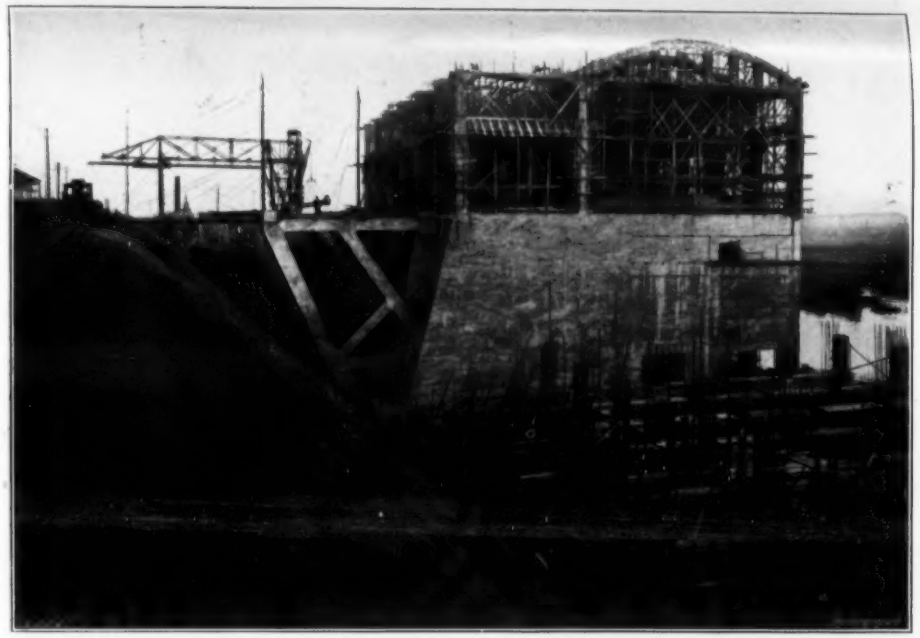


NO. II.—GENERAL VIEW OF WORK, ORE SILOS IN BACKGROUND—JANUARY, 1925

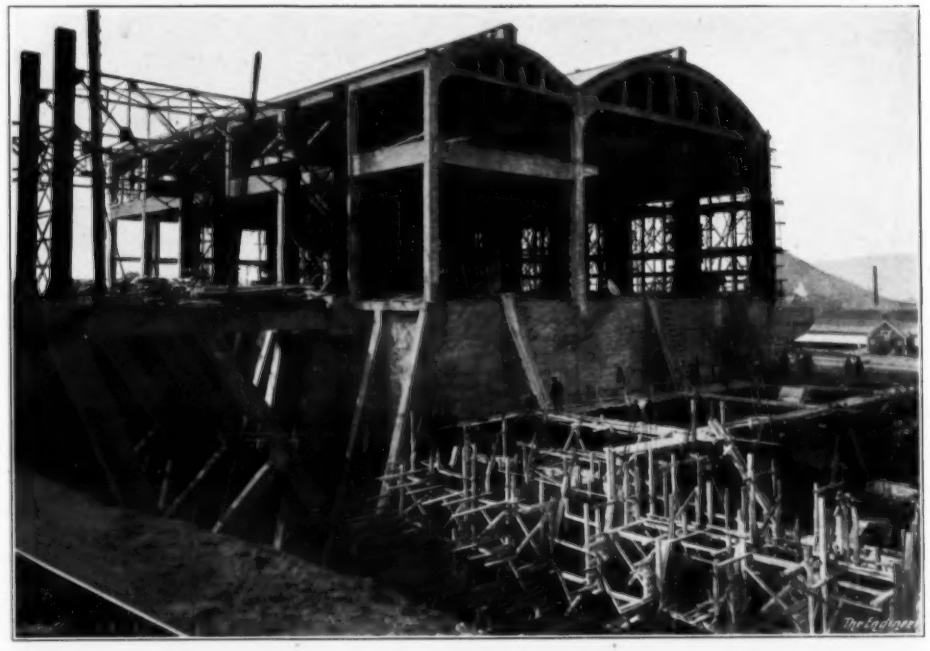
NO. III.—SHUTTERING FOR COAL RECEIVING HOUSE—JANUARY, 1925



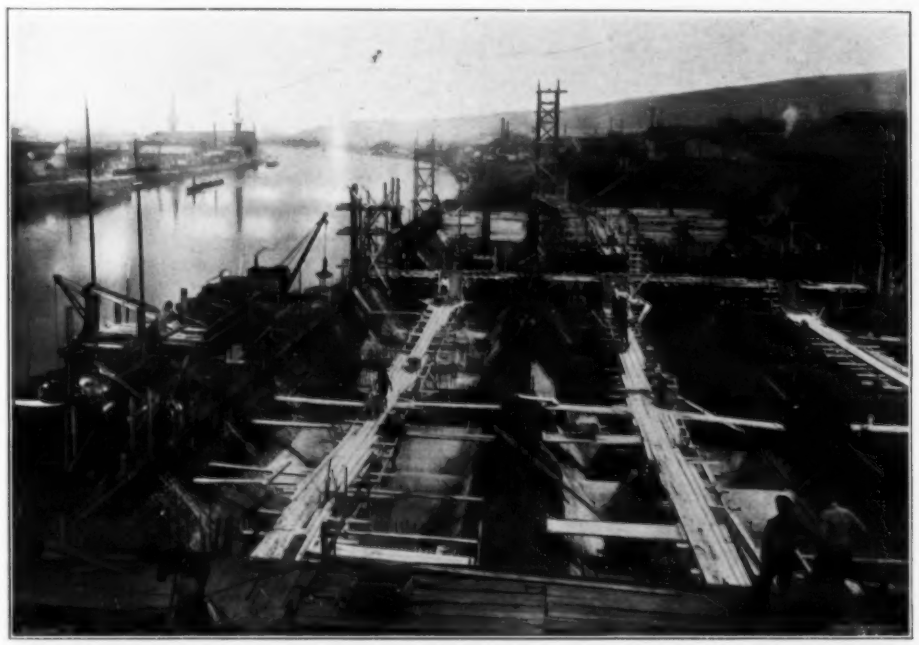
NO. V.—COAL PREPARING HOUSE—JUNE, 1925



NO. VI.—END VIEW OF COAL PREPARING HOUSE—JULY, 1925



NO. VII.—COAL PREPARING HOUSE—AUGUST, 1925



NO. VIII.—CONSTRUCTION OF HOPPERS OF COAL SILOS—AUGUST, 1925

UNIV. OF MICH.

Courtesy of the Gardiner Museum, Toronto, ON, 2021

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.

CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.

EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.

FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.

BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.

ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto I, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.

JAPAN.—MARUZEN CO., Tokyo and Yokohama.

AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.

AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.

CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386-388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.

CEYLON.—WIJAYARTNA AND CO., Colombo.

JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.

NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.

STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.

UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly ..	£1 11s. 6d.	Half-yearly ..	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum.
Thick paper edition .. £3 3s. 0d. „

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The Charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER DIRECTORY," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practicable regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

"THE METALLURGIST"—BINDING CASES.

Cloth Binding Cases for twelve issues (one year) .. .. 2s. 0d.
Subscribers' own copies, including cases, bound Cloth .. 4s. 0d.
Bound half roan 7s. 6d.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2266, 2267 Central.

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Plate illustrating the Ore and Coal Silos at the Ougrée-Marihaye Steel Works. Every number, as issued by the Publisher, contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, December 17th, 1926. PAGE

A SEVEN-DAY JOURNAL .. 653
REINFORCED CONCRETE SILOS AT THE OUGREE-MARIHAYE STEEL WORKS. No. II. (Illus.) .. 654
MODELS AND ANALOGIES FOR ILLUSTRATING ELECTRICAL PRINCIPLES. No. XIX. (Illus.) .. 655
MARINE OIL ENGINE TRIALS COMMITTEE .. 657
SIXTY YEARS AGO .. 659
INDIAN ENGINEERING NOTES. (Illus.) .. 660
POWER FROM THE TIDES .. 661
SURFACE-HARDENED GEAR TEETH. (Illus.) .. 661
RAILWAY MATTERS .. 663
NOTES AND MEMORANDA .. 663
MISCELLANEA .. 663
LEADING ARTICLES—
London Bridges .. 665
Technical Societies .. 666
AIRCRAFT DEVELOPMENT IN FRANCE .. 666
THE ELECTRICITY COMMISSIONERS' REPORT .. 667
BOOKS RECEIVED .. 667
KRISTOFER POLHEM. (Illus.) .. 668
THE INSTITUTION OF CIVIL ENGINEERS .. 668
AN AUTOMATIC HIGH-PRECISION SCREW-CUTTING LATHE. (Illus.) 669
LETTERS TO THE EDITOR—
The Training of Engineers .. 671
An Old Hydraulic Ram .. 671
Steam Wagon Design .. 671
A ROOF-STICK BENDING MACHINE. (Illus.) .. 672
SOUTH AFRICAN ENGINEERING NOTES .. 672
MANCHESTER ASSOCIATION OF ENGINEERS .. 673
CONTRACTS .. 673
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 673
Lancashire .. 673
Sheffield .. 674
North of England .. 674
Scotland .. 675
Wales and Adjoining Counties .. 675
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 675
CURRENT PRICES FOR METALS AND FUELS .. 676
FRENCH ENGINEERING NOTES .. 677
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 677
FORTHCOMING ENGAGEMENTS .. 678

TWO-PAGE SUPPLEMENT—ORE AND COAL SILOS AT THE OUGREE-MARIHAYE STEEL WORKS.

THE ENGINEER.

DECEMBER 17, 1926.

London Bridges.

LONDON will never satisfy everybody. It will always be a city of makeshifts. It has grown up without plan or organisation round a little area, about one mile in diameter; it still goes on growing in much the same way. Here and there the scientific town-planners have had their way, but for the greater part London expands by the engulfing of the towns and villages that surround it, and the local characteristics are sewn into its expanding hem. It is a vast patchwork quilt, each patch retaining some of its own peculiarities and taking a shape which is controlled by conditions which have existed for centuries. It is therein that lies much of its charm. It is not a scientific city, it is not laid out according to plan, it is unceasingly changing, and with every change some little bit of its past history is retained. One cannot build the "perfect" city in that way, and we may be thankful for it. Our London has a character which the "rectangularists," the "circularists," the "radialists," and whatever other "ists" there may be who have schemes for reconstructing it on a plan which would make it perfectly efficient, perfectly homogeneous, perfectly regular, could never give it. There is no Londoner that does not really like his London as it is. He grumbles about it; he complains of the blocks in the traffic; he criticises its buildings; he abjures its grimy face, its tortuous streets, its slow-moving vehicles upon busy thoroughfares, its absence of parking spaces, the position of its railway termini, its bridges, its great distances. But take it for all in all, he would rather have it the glorious mixture that it is, whispering history at every corner, than a perfect city laid out by line and compass, and with every street made to suit the actual or prospective volume of traffic. No true Londoner wants to see London altered too much. If two Wren churches interfere with the traffic in the Strand, then the traffic must be put to inconvenience, but St. Mary's and St. Clement's must not be touched. If St. Paul's stands in the way of an efficient north-south highway, the highway must go elsewhere. St. Paul's must not be crowded, the peaceful oasis in which it stands must not be narrowed; if a group of old houses breaks in upon a building scheme or prevents street widening, not till every other means has been exhausted must they be removed or interfered with. This love of London may give despair to the reformers, but happily it is so engrained in the heart of all genuine Londoners that it is never likely to be wholly lost. London will always be a history book.

There is perhaps nothing that gives so much character to a city as its bridges. Not only do they in themselves reflect the æsthetic feelings of the community at the time they were erected, but they are modified by or react upon the districts which they serve. One is mainly a bridge for the suburban dweller, a passenger bridge; another groans under loads of merchandise; a third carries both. Consider, for example, Westminster Bridge, the most used of all London's sixteen bridges. It carries daily 12·4 per cent. of all the cross-river passenger traffic and 3·1 per cent. of trade traffic, and contrast it with the Tower Bridge, which has very little passenger traffic—actually 1·1 per cent.—but takes 7·1 per cent. of the total trade traffic that crosses the river. Again, we have bridges like Waterloo and Southwark, which are equally used by trade vehicles and by passengers. Again, one bridge may debouch into a dense area of factories and warehouses, and another into open spaces where the heavy lorry never tarries. These facts have to be borne in mind. "Bridges," say the Royal Commissioners of Cross-River Traffic, "cannot be regarded merely as means of getting from one bank of the river to the other, and must always be considered in connection with both their immediate and their more distant approaches. Properly looked at, a bridge is only a link in a line of communication, and the use made of it is largely determined by the extent to which its approaches are adequate and convenient." That ought to be an obvious fact, but that it is overlooked even in the highest quarters is made plain by the desire of the London County Council to build a new Waterloo Bridge wide enough to carry six lines of vehicles, and, if rumour was right, to bring trams right up to the Strand. We pointed out in our issue of January 26th the unwisdom of that proposal, and we are glad to see that the Royal Commission reports that "We do not think that it is either necessary or desirable that a bridge of such dimensions should be erected at this spot. It could not be fully utilised unless the streets on both sides, and particularly on the northern side, were greatly altered. Otherwise the bringing of more traffic over the bridge would only intensify the congestion in the Strand." We shall return to the problem of Waterloo Bridge, and only mention this aspect of it here to enforce the Commissioners' observation that bridges must be considered in connection with roads which they connect. The five central bridges—London, Blackfriars, Waterloo, Westminster and Vauxhall—carry now no less than 60 per cent. of the daily flow across the Thames. To relieve them of some of that traffic and to distribute it over a greater area, the St. Paul's Bridge has been advocated for many years. But the objections to it are considerable, and the Commission has definitely decided against it. At the same time, the need of further cross-river accommodation is so urgent that the Commissioners recommend the construction of a new bridge—"Ludgate Bridge"—in juxtaposition to the Southern Railway Company's bridge at Blackfriars, with a high-level causeway, will form the approach at each end, one terminating in Southwark-street and the other on Holborn Viaduct. Of its recommendations, this seems to us to be the least desirable, and we are doubtful that it will put the question to rest. Indeed, the Commissioners themselves accept it as a *pis aller* because the expense of a more practical scheme was too great. At the western end of the dense area relief would be afforded by the imposing scheme which the Commissioners put forward. This scheme is the erection of a double-deck bridge where Hungerford Bridge now stands. It would carry the railway below and a roadway above. The roadway would be continued for some distance northward across the Embankment and Strand—with 18ft. of head room—up to St. Martin's-place and southward by a long easy gradient to Westminster Bridge-road or Blackfriars-road. Costly as this scheme must be, it has the very great advantage that the approaches to the bridge will not interfere with the traffic in the great thoroughfares adjacent to and parallel to the river. It is hoped, furthermore, that it will not attract traffic intended for those thoroughfares.

The Royal Commission was appointed as the immediate result of the public feeling with regard to Waterloo Bridge and in its decision with regard to that structure lies its chief interest to engineers. The construction of new bridges may bring in time its own proper problems, but the problem of Rennie's bridge has already been with us for many months. The discussion of it progressed up to the point when the London County Council had decided upon demolition and rebuilding upon a larger scale. It was only then, when the life of the revered structure was at stake, that someone bethought him that there was more in the matter

than the saving or destroying of one bridge. The narrow view taken by the County Council did not permit it to see all the issues involved. Its attention was riveted upon the bridge as a bridge. It did not think of it in connection with the greater problem of cross-river traffic as a whole. The Commission was set up to do what the Council ought to have done before deciding to build a bridge nearly twice as wide, and has now, after a complete and very instructive review of the whole problem, reversed the recommendation of the Council, both on practical engineering grounds and upon the grounds of convenience of traffic. We cannot here refrain from quoting a passage which occurred in our Retrospect of 1925: "With the contention that the bridge is no longer fit for its purpose we find ourselves in little sympathy. The object of those who would pull it down is to put up a wider structure, and it is commonly said that the London County Council desires to run tramways across it. Such a course, we are convinced, would add further to the difficulties of London traffic by making still greater concentration upon an already congested centre. That the connection between the right and left banks of the river is inadequate is admitted, but it should be increased, not by the widening of a bridge at an already overburdened centre, but by the building of one at another point so that concentration of traffic may be minimised. With the provision of a new bridge elsewhere Waterloo would remain amply wide for all the traffic that can be accommodated at the Strand end, and the retention of the famous structure would be made possible. Even at this late hour, when the London County Council has decided upon its destruction, we cherish a hope that a course more consonant with the feelings of all who have the sensibility to appreciate the artistic merit of Rennie's bridge and its absolute fitness with its surroundings may prevail, and that the bridge may be restored with no material alterations to its appearance." The recommendation of the Royal Commission is in absolute accord with this passage. The Commissioners, as we have already seen, believe that a six-line bridge would cause congestion in the Strand, and after careful inquiry they are satisfied that the structure itself can be saved. They do indeed recommend a certain amount of widening, but, if we may so put it, rather with the object of making the present width fully effective than of adding new capacity to the roadway. The road is now 27ft. 6in. wide, and should accommodate three lines of traffic. But there is barely enough room, and by increasing the width to 35ft.—no more—the bridge may be brought up to its true capacity. It may even carry four lines, though a width of 40ft. is usually deemed necessary for that number. Into the technical aspects of the reconstruction the report does not go very deeply. It has accepted the opinion of Sir Alexander Gibb that by taking down piers and arches Nos. 3, 4, 5 and 6 and rebuilding them, and by underpinning the landward piers on each side, the bridge can be perfectly restored, and it is satisfied that the moderate widening which it deems essential can be effected without materially affecting the harmonious appearance of the structure. This is a decision of the greatest interest, not only to engineers who must desire to see so famous a work preserved, but to all those whose main motive for urging the preservation of the bridge was æsthetic or sentimental. We sincerely trust that it may be final, and that the work of restoration will be put into hand by the County Council at once.

It has not been possible in the space which we could allow ourselves for this review of the Royal Commission's report to do more than touch upon one or two of the subjects of most interest to engineers. Other recommendations have been made familiar to all who are interested in London by the abstracts printed in the daily papers, and we have little doubt that the report will be as widely read as it deserves to be, both on account of its moderation and the comprehensive view which it gives of the whole problem of cross-river traffic. The Commission's scheme for the reconstruction of Charing Cross Station—on the north side of the river—and of a great double-decked steel bridge and viaduct is of exceptional interest to engineers, but there is no part of the report which will give more satisfaction to the public generally than the decision which it has reached with regard to Waterloo Bridge.

Technical Societies.

THERE is perhaps nothing which shows so clearly the ubiquity of engineering as the number of technical societies devoted to it and its allied subjects. In this country alone they number approximately a hundred, of which something like one-half are "national" societies, whilst the remainder are local, provincial or "country" institutions. That the limit has even now been reached is far from certain. Only within the past year two new bodies—wisely now amalgamated into one—have been formed for the study of fuel technology, and the establishment of others for specific purposes is being advocated in certain quarters. Many of the institutions are quite small, numbering at most a couple of hundred members, and none approach the membership of the Institutions of Civil, Mechanical and Electrical Engineers. But many of the others, as, for example, the Institution of Naval Architects, the Iron and Steel Institute, the Institute of Metals, and the two great Northern institutions, exert great influence, whilst many of the other smaller societies do a great deal of admirable and useful work. Yet the existence of so many technical institutions without any co-ordination between them is giving some anxiety, and we are glad to say that there is a gradually growing feeling that some means of drawing them together should be found.

It was particularly satisfactory to observe from remarks made by its President, Mr. William Reavell, after its annual dinner last week, that the Institution of Mechanical Engineers is alive to the matter. Mr. Reavell said: "This seems a fitting opportunity to refer to the growth of independent societies and institutions which are formed to deal with some specific development of engineering which the sponsors of such new institutions consider cannot be dealt with adequately by the mother Institution. I would not venture to criticise their judgment, but as mechanical engineering is the basis of practically all these developments, I picture a larger and still more important Institution of Mechanical Engineers in the future, with larger premises, and acting as the Mother Institution which can furnish a home for its numerous offspring, and yet reserve for each of them that separate autonomy which may be considered necessary for their free development. The recent findings of the Imperial Conference seem to provide the proper analogy. This matter is engaging the attention of the Council at the present time." We may gather from these remarks that the Institution has in view not only some kind of affiliation with kindred societies, but that it is seeking for some means of establishing a physical connection with them through the extension of its building. This is a step in the right direction. The differences which exist between the qualifications which are required for membership by various societies would seem to render complete amalgamation with more than two or three impossible, but a scheme for affiliation which would give other societies the advantages of a connection with the parent Institution, whilst leaving to them their complete autonomy, is quite within the realms of possibility. The advantages of such a course need not be stressed. Under the present circumstances a great deal of material, as well as intellectual, overlapping occurs, and is bound to occur. On the material side, we need go no further than to allude to the provision of technical libraries. If the library of the Institution of Mechanical Engineers—to take but one—were open to a much larger number of members, it would not only not be unduly stressed, but it would be able to extend its scope with advantage to many others besides its own members. On the intellectual side, there can be little or no question that the holding of conjoint meetings provides an admirable means of extending knowledge, and so of benefiting the profession and industry of engineering. Finally, there are occasions—the Admiralty's attack upon the status of engineers provides an admirable example—when a united front, a front which included all or the greater part of the engineering societies of the country, would double and treble the influence that could be exerted.

The advantages of amalgamation have always been recognised; but the difficulties of effecting it have so far proved insurmountable. If, as its President seemed almost to hint, the Institution of Mechanical Engineers has indeed struck upon some course which will bring the institutions of the country together, even if it be in no more than a loose way, which will leave each unit complete autonomy, it will go far towards effecting that unification of interests which has been sought for unsuccessfully for the past twenty years.

THE structure of the new lighthouse at Hartlepool has been finished, but it still requires the installation of the electrical machinery, and will not be in use until February.

Aircraft Development in France.

IN view of the efforts being made to develop public air services in France, there was reason for hoping that the Paris Show on December 3rd would have revealed some noteworthy progress in commercial flight. Some such progress has certainly been made, but it was not observable at the Show, which was more conspicuous for the number of military types of machines. So long as French aircraft builders have to depend for their custom mainly upon the requirements of home and foreign Governments, they have little opportunity to develop the commercial side of the industry. The problems involved in the designing of military machines are not the same as those which confront the builder of commercial aeroplanes, who has to strive after low cost per ton-mile of load and perfect safety in flight. Progress on the commercial side of aviation can therefore only be assured when builders find sufficient encouragement in a demand for public service machines. During the past year there was some trouble over the policy pursued by the late Under-Secretary of State for Aeronautics, who aimed at concentrating the industry instead of encouraging competition. As the factories could only exist with the aid of State subsidies, he argued that it was better to support a few works and let the others drift to failure or else amalgamate. That policy was strongly opposed in Parliament, on the ground that the Government would be relieved of the necessity of paying subsidies, or what amounted to the same thing, paying high prices for aeroplanes, if it encouraged competition. Therefore, it was necessary to provide all aircraft builders with sufficient work, and it was hoped to find them employment by developing more actively the civil side of aviation. Until this is done, the Paris Shows will continue to give prominence to military types of aeroplanes which constitute the main production of the industry. A larger number of makers exhibited, and they are all looking forward to a renewed activity following upon the development of commercial flight.

Some of the foreign machines made a distinctly favourable impression. The stand of Sir W. G. Armstrong, Whitworth Aircraft, Ltd., was vacant on the first days of the Show, but the Dutch Aeroplane Works, at Amsterdam, exhibited a Fokker monoplane fitted with three Jupiter engines, and weighing 4 tons with a paying load of 1 ton. The Fiat military biplane was entirely metallic, with a twelve-cylinder engine of 410 horse-power. The Czecho-Slovakian industry was represented by biplanes with Jupiter engines built by Messrs. J. Walter and Co., of Prague. Amongst the French exhibits, the chief differences, as compared with those shown on previous occasions, were the larger number of monoplanes and the all-metal construction which is steadily gaining ground. In some of the biplanes the lower plane was shortened to the extent of serving little more than to strengthen and consolidate the machine. In general, however, the biplane, with thicker wings and heavy section struts to replace the wire stays formerly employed, still holds its own for the larger machines. All the aeroplanes exhibited were standard types, and there appeared to be nothing of an experimental character in the whole Show. Hence, the visitor received the impression that the aircraft industry has developed definite and final models of machines, which, of course, is not the case; for although little is now heard of experimental machines involving new principles, plenty of experimental work is being done in various directions.

Attention was always centred so largely on military aeroplanes that scarcely anything was done with seaplanes and flying boats until the Government found it necessary to offer special encouragement in the way of competitions with suitable prizes, and this new branch of the industry is now being specialised mainly by such firms as Lioré-Ollivier, Marcel Besson et Cie, Schreck, F.B.A. and Cams. The form of flying boat is more nearly approached by the Loiré-Ollivier machines, and in most of the seaplanes the combination of biplanes and boat-shaped fuselages is obviously intended to meet naval requirements, and at the same time permit of the machines being adapted for commercial purposes. The value of the seaplane, apart from purposes of national defence, is being fully realised in France now that the Mediterranean is regarded as an air route, and seaplanes have been employed very successfully for colonial exploration, notably on the Niger and other rivers. This section of the Paris Show was therefore particularly interesting, although in many respects not altogether convincing. The seaworthiness of some of the machines may perhaps leave something to be desired. The Schreck machine is a biplane with boat-shaped fuselage to which folding wheels are fitted, so that the pilot can let them down when landing. In the Besson seaplane the boat is rigidly suspended from a plane, on the fore edge of which are mounted three Jupiter engines, giving a total of 1140 horse-power. The plane has a surface of 130 square metres. The machine weighs without load about 5 tons, and will carry a total load of 2½ tons. The seaplane industry is still capable of development if it can be freed from the influence of the old type of aeroplane fitted with floats. On account of the space available at the Show only a few machines could be

exhibited, but the Naval Department had a section of its own, in which was a model of the Béarn, which has been transformed into an aeroplane carrier. The construction of that battleship of 22,000 tons was stopped after the Armistice, and it was re-designed with a platform, 182 m. long above the deck, so that the machines are able to take off and land without fear of obstruction. The navigation bridge is on the side of the deck. There is accommodation under the platform for twenty-seven machines. The transformation of the Béarn for the carrying of aeroplanes was decided upon before the future of the seaplane appeared to be assured.

In the construction of engines French makers are still debating the merits of air and water-cooled engines, and as this business is mostly in the hands of automobile firms, it is only to be expected that they should show a preference for types of engines from which they are sure to get the best results. It is argued that any system of air circulation around webbed cylinders will not ensure regular cooling, with the result that the lubrication becomes defective and the efficiency falls, and it may lose the advantage of weight per horse-power. The French air-cooled engines have practically disappeared, except for small powers, and their place has been largely taken by British air-cooled engines, the prominence of which on the international market was one of the features of the Paris Show. At one time many firms laid themselves out specially for the construction of aero engines of almost every conceivable type, but they have all gone, and engines of high powers are now supplied by such motor car firms as Hispano-Suiza, Renault, Lorraine-Dietrich and Panhard. They are mostly twelve cylinders and rated at 450 horse-power, the cylinders being arranged V shape or in the form of a W. A Renault engine was shown capable of developing 700 horse-power. Both the Renault and the Lorraine engines had reduction gears for the propellers. They are necessary for propeller efficiency, but few engine makers care to adopt them on account of the difficulty of making gears that will stand up to the work.

As the Show was intended to interest the public and educate it to a practical appreciation of the commercial side of aviation, there were elaborate exhibits showing by models and pictorially the extreme care taken in the manufacture, testing and selection of material used in the construction of aircraft. There was a fully equipped laboratory and models for demonstrating the scientific side of aeroplane design, such as the theory of streamlines, the flow of liquids, air pressures and the like. All this was necessary to establish public confidence in the aeroplane. In a country which so long held a lead in the aircraft industry, the public is singularly reluctant to profit from the facilities offered by air services. The proportion of French travellers on international lines is very small, and if France is to develop civil aviation in competition with other countries she must be assured of a sufficiently large revenue from passenger traffic. The whole future of the services depends upon the way in which Frenchmen can be induced to travel in aeroplanes. One of the objects of the Paris Show was to convince them of the safety and economy of this means of transport. Until this is done there can be little hope of organising successfully the national lines which are regarded as indispensable if the international airways are to become profitable.

While the French constructed aircraft mainly for military purposes, the Germans, being debarred from building machines of military types, turned their attention entirely to civil aviation, and a map of the air system in Germany shows how thoroughly that country has organised a network of national lines to serve as feeders for the international airways. There are more than 10,000 miles of airways, most of an experimental and intermittent character, and the machines fly an aggregate total of 25,000 miles a day. The international lines already connect most of the continental capitals, and they are to be extended to South America by way of France and Spain, while a route is being prepared for a line to India. Such an organisation could not fail to court disaster so long as several companies were competing for the subsidies offered by the State and the municipalities, and when the State threatened to withdraw the subsidies unless all these conflicting interests were amalgamated, the Luft Hansa was formed to monopolise the air services, which are now run almost with the regularity and precision of railways. This result is causing some concern to the French, who find it necessary to embark upon an extensive policy of air service organisation in order to provide employment for the aircraft factories. The propaganda in favour of creating feeder lines, similar to what has been accomplished in Germany, has now reached the stage of practical realisation, the first line to be run putting the northern departments into communication with Paris; but in view of the excellent train services in France, and the present reluctance of French people to travel by aeroplanes, there is considerable doubt whether the lines will be of real utility and whether they can be made to pay their way. The idea of the feeder lines is that they will be served by light aeroplanes fitted with low-powered engines, which will be economical for the carriage of mails and parcels, but, owing to the comparatively short distances covered, the gain in time over fast trains will not give to aeroplanes a preponderant advantage over the railways. In Germany it is proposed to use the airways eventually for all express traffic and to suppress the fast trains for reasons of economy. It is explained that if anyone finds it necessary to travel fast, he will be prepared to pay for the privilege of flying faster than he can go by train. There was nothing in the Paris Show indicating that the French aircraft industry is prepared to supply reliable light aeroplanes, except a Caudron machine with a 40 horse-power engine, which was declared to be the only light aeroplane to receive a navigation licence entitling it to be employed for public service.

Although the creation of national air lines is still in an initial stage, the French are making arrangements to ensure that they will not be forestalled by Germany in organising a service to South America. They affect to believe that the Germans are running a risk in sending huge seaplanes and airships across the southern Atlantic, and on the principle of "safety first," they intend, in the coming year, to utilise the existing aeroplane service between Toulouse and Dakar, in Senegal, which will be extended from the latter port by seaplanes to the Cape Verde Islands, by fast boats between Cape Verde Islands and the island of Fernando-Noronha, by seaplanes from Noronha to Pernambuco, and thence to Buenos Aires by aeroplanes. In the coming year also a line, following the Mediterranean, will be inaugurated between Marseilles and Bagdad, with an extension almost immediately to India, and eventually to Indo-China. The coming year is therefore likely to see some interesting developments in international air services on account of the entirely different methods adopted by the French and the Germans.

The progress of aerial photography was demonstrated in many ways at the Paris Show. A machine for redressing perspective and necessarily distorted air views was shown by Mr. Carl Janzer, jun., of Stuttgart, who bases his system upon the changing focus of the reproducing lens in combination with a focal plane, the movement of which must synchronise with the movement of the lens. This is done automatically by a machine of great precision actuated by a small electric motor.

The Electricity Commissioners' Report.

THE sixth annual report of the Electricity Commissioners has just been issued. The outstanding feature of the period covered was the announcement by the Prime Minister in January, 1926, of the proposals of the Government with regard to electrical development, followed in March by the introduction of the Electricity (Supply) Bill, 1926, into Parliament, and by the publication of the report of the Committee presided over by Lord Weir, upon which the Bill was mainly based. The provisions of the Bill are set forth in the early part of the report, but they are now well known and need not be considered here.

The report contains, as usual, a good many tables, the first of which shows that on March 31st, 1926, the total number of undertakers holding statutory powers in England, Wales and Scotland was 596, representing a net addition of 28 to the number for the preceding year.

As compared with those for 1925 the returns for the year ending March 31st, 1926, show an increase of about 9·5 per cent. in the number of units generated and an increase in the consumption of coal and coke of about 5·2 per cent. The consumption of oil fuel showed a decrease of 15,600 tons, a reduction of over 28 per cent. on the consumption during the preceding year. Figures for 1925 show that the sales of electricity by authorised undertakers increased by upwards of 50 per cent. since 1922. On the basis of the estimated population of Great Britain in 1925, namely, about 44,000,000, the units sold by authorised undertakers in that year represented an average consumption of the order of 125 units per head of population, irrespective of the supplies utilised for traction purposes and generated at the stations of railway and tramway authorities, or of the large supplies generated privately at stations belonging to industrial and commercial organisations. At the end of the period covered by the report, schemes for the improvement of the organisation for the supply of electricity in eight electricity districts had been approved by Parliament, and had come into force. Six of these schemes came into operation during earlier years, the two additional schemes approved by Parliament subsequent to April 1st, 1925, being in respect of the London and Home Counties Electricity District and the West Midlands Electricity District.

The aggregate capacity of the generating plant for new stations and extensions to existing stations sanctioned by the Commissioners during the year 1925–1926 amounted to 585,700 kilowatts. The rate of provision for meeting the growing demands upon electricity undertakings thus showed a substantial increase on the figure of approximately 480,000 kilowatts recorded for the previous year. Of the 2,821,693 kilowatts of generating plant sanctioned during the past six years 473,110 kilowatts, or approximately 17 per cent., was for new stations, and 2,348,583 kilowatts, or 83 per cent., for the purpose of extending or remodelling existing generating stations. As indicated in earlier reports, however, the capacity of the generating plant sanctioned by the Commissioners does not represent a net addition to the plant capacity of the country, as in a number of instances the installation of the new plant involved the displacement of other equipment of an obsolete type.

During the year covered by the report, the Commissioners issued sixteen consents—ten to authorised undertakers and six to non-statutory undertakings—in respect of the establishment of new generating stations, representing the initial installation of plant having a total rated capacity of 46,460 kilowatts. The Commissioners also had under consideration during the year other important applications from authorised undertakers relating to the establishment of new generating stations. The sanctioned extensions to existing stations represent in the aggregate a plant capacity of approximately 539,200 kilowatts, as compared with the figure of 463,200 kilowatts for the preceding year, the division of the total as between the various authorities being approximately as follows:—Local authority undertakers, 218,300 kilowatts; company undertakers, 292,200 kilowatts; railway and tramway authorities, 28,000 kilowatts; and non-statutory undertakings, 700 kilowatts.

As in the previous year, the Commissioners dealt with a number of important applications for consent to the establishment of main transmission lines for the purpose of further developments in conformity with the schemes of reorganisation for various districts and for the giving and taking of bulk supplies. The Commissioners issued formal consents under Sec. 11 of the Act of 1919 in respect of forty-two applications and a complete list of the consents giving the names of the undertakers concerned and brief particulars of the respective main transmission lines is included in the report. Sixteen of the consents related to 33,000-volt transmission lines and one to 66,000-volt lines, the undertakers in the latter case being the Newcastle-upon-Tyne Electric Supply Company, Ltd.

At the commencement of the period covered by the report, seventy-nine applications for special orders under Sec. 26 of the Act of 1919, relating to the establishment or extension of distribution undertakings, &c., were under consideration by the Commissioners, and during the year under review ninety-three further applications were received. The Commissioners made during the year special orders in respect of applications before them and submitted them to the Minister of Transport.

The Commissioners approved of the adoption by fifteen authorised undertakers (in respect of sixteen undertakings) of systems of supply other than the general system previously approved by the Board of Trade and the Commissioners respectively. Under their regulations for ensuring a regular and efficient supply of electricity, the Commissioners issued fifteen consents during the year to an alteration in the declared system and/or pressure of the supply hitherto adopted by fourteen different authorised undertakers. A review of the seventy-seven consents given by the Commissioners during the last six years shows that a considerable measure of success has resulted from the efforts which have been made to secure the elimination of the various odd frequencies in vogue in different portions of the country, and also a change-over from direct-current to alternating-current systems of distribution. Of the consents in question, fourteen were in respect of alterations to the standard frequency of 50 cycles per second from existing frequencies of 25 cycles in two cases, 40 cycles in one case, 60 cycles in three cases, 67½ cycles in one case, 77 cycles in one case, 83⅓ cycles in one case, 87½ cycles in one case, 93 cycles in one case, and 100 cycles in three cases. Alterations from direct-current distribution to alternating-current distribution formed the subject of fifty-three consents, of which forty-seven provided for 50-cycle alternating-current systems.

BOOKS RECEIVED.

Electric Trains. By R. E. Dickinson. London: Edward Arnold and Co., 41, Maddox-street, W. Price 16s. net.

The "Express" Metric Quotation Reckoner. By J. Gall Inglis. London: Gall and Inglis, 31, Henrietta-street, W.C. 2. Price 2s. 6d. net.

Practical Engineer Mechanical Pocket Book, 1927. Edited by E. G. Beck. London: The Oxford University Press, Falcon-square, E.C. 1. Price 2s. 6d. net.

The Practical Engineer Electrical Pocket Book, 1927. Edited by Conrad Arnold. London: The Oxford University Press, Falcon-square, E.C. 1. Price 2s. 6d net.

Design and Construction of Formwork for Concrete Structures. By A. E. Wynn. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W. 1. Price 20s. net.

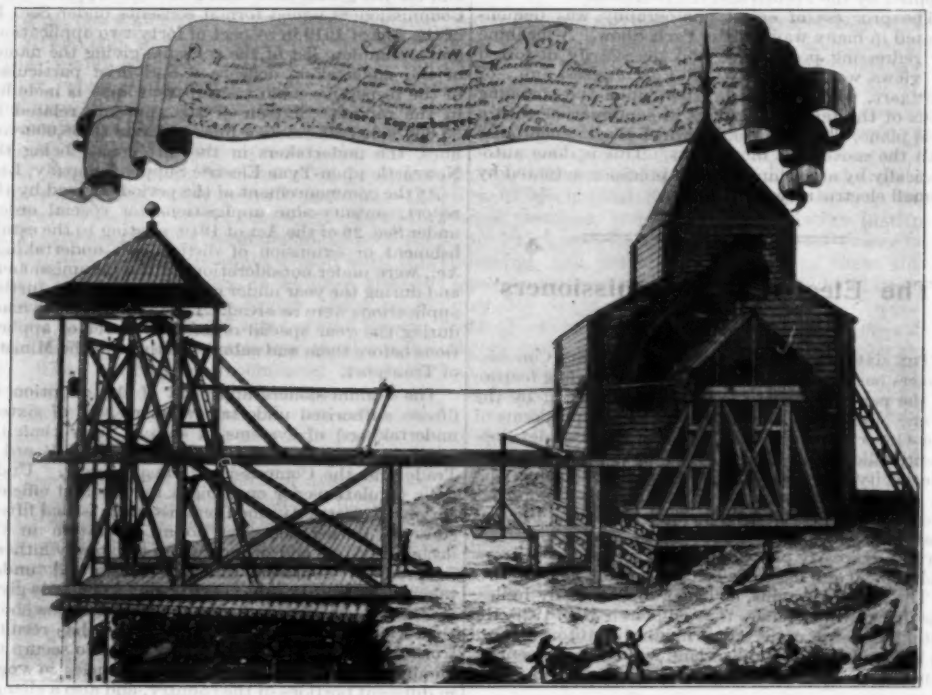
International Register of Telegraphic and Trade Addresses, 1926–27. London: The Marconi International Code Company, Ltd., Marconi House, Strand, W.C. 2. Price 27s. 6d. net.

"Transactions" of the Institution of Engineers and Shipbuilders in Scotland. Volume LXIX., 1925–26. Glasgow: The Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent.

Kristofer Polhem.*

By JOHN G. A. RHODIN, F.I.C.

It is a strange thing that most European countries have produced an abundance of great intellects during their periods of successful political struggles leading to political greatness. In England the Elizabethan period is a case in point and it is pleasant to record that the names of William Shakespeare and Francis Bacon probably lend a greater lustre to that time than those of the martial heroes. The case was similar in far-off Sweden a century later when the Baltic was a Swedish lake, thanks to the military genius of kings and others. To vitiate the parallel Gustavus II. Adolphus was such a truly great man in most respects and Charles XII. such an outstanding tragic figure, that their names dimmed the lesser lights in the eyes of the world. What is not generally known is that Sweden during the period in question produced great engineers. Two of them, Erik Dahlberg and Kristofer Polhammar, sprang from the people, and both were ennobled, the latter with the name of Polhem. Dahlberg was a military engineer, who served under Charles X., XI. and XII., and wrought wonders of skill in building and destroying fortifications, roads, bridges, &c. The story of his long life is an epic of incessant work for the glory of his country, about which he wrote and illustrated his "*Suecia Antiqua et Hodierna*," published in 1701, a eulogy inspired by the triumphs of Charles XII. This enormous work, by far the most imposing book on Sweden in existence, contains a fairly exact history of his time, with other embellishments than the illustrations, as was the custom in those days, and most of the published history of the Swedish internal development during the period can be traced to its pages. He devoted some space to the early history of Polhem, and one of my illustrations comes from that source.



POLHEM'S WATER-DRIVEN MINING HOIST

Kristofer Polhammar was born in 1661, and started life as an "estate writer," or clerk to the Vansta and Follnäs estates in Sudermania, the province in which the southern part of Stockholm is situated. He managed, however, by great sacrifice to enter Upsala University, where he studied the natural sciences and showed his leaning towards applied mechanics by improving and putting in action the astronomical clock in the cathedral, which was made in 1506 by a certain Petrus Darypodius, Professor of Astronomy, and showed the phases of the moon and the position of the planets during the whole year. From Upsala he was appointed mining engineer at Stora Kopparberget, the famous copper mine. Here he introduced improved derricks for handling the blasted rock, and designed a new water-driven headgear for haulage—illustrated above *ex Suecia Antiq. et Hod.* This was done in 1694, and the arrangement was described as a "machina nova" by various authors. During the period ending 1714 Polhammar made numerous inventions relating to mining and working of metals, and he probably caused interest in government circles by his invention of the elevating screw for cannon, somewhere about 1710. Anyway, Charles XII. appointed him "Assessor" in the Board of Trade, and ennobled him with the name of Polhem in 1714, when he was fifty-three years of age.

From this time his history as a great civil engineer began and lasted for several decades, a somewhat nasty knock for the "too-old-at-forty" theory. Unfortunately, I have not got his own description of his main mechanical inventions at my disposal, but such an one was published in 1729. One must, however, conclude that he had done a lot before 1714 to become observed by a somewhat despotic government in days of great stress. He was called upon to make the dock gates for the dry docks, blasted in the rocks by Francis Sheldon at the naval port of Carlskrona. These docks, which accommodated line-of-battle ships, were the largest in existence during a long period. Polhem also built the old lock at Stockholm, which unites the Malar Lake with the Baltic. In 1716 he was called on to make a system of locks to make the Trolhättan waterfalls passable by ships. A contract was signed in 1718, but the work was discontinued through the death of Charles XII. on November 30th, and through the stress of the following troublesome times. Polhem was, however, called in to assist in carrying out his plan in 1749 when he was eighty-eight years of age. The blasting of Polhem's lock was supervised by him, but the gates were never put in. When this was going to be done, four years after his death, the dam holding the water back was destroyed by some people letting 900 dozen heavy planks drift down the upper falls, smashing the dam to pieces. This happened in the night between September 19th and 20th, 1755, and Polhem's daring plan was doomed for ever. To enter into details of this plan is beyond the scope of these notes, but a few words may be said to illustrate the magnitude of the undertaking.

Polhem's intention was to harness the falls themselves with locks, not to build a canal round them. These falls carry some 500 tons of water a second or more for some 300 days of the year, as they are fed by Lake Wenern, the second largest lake in Europe, which has no other outlet, and hence they are not vitally affected by drought. The total available difference of level is some 30 m. between top and bottom waters at rest, but the falls lie one after the other for a long distance. Polhem intended at first to dam up the whole of Lake Wenern for three months, which he calculated would raise its level 4ft. As he estimated the flow at 400 cubic fathoms a second, this was well above the mark. He actually started the work on this plan in 1718, but it had to be abandoned, as stated above. The plan adopted in 1749 was no less daring, involving as it did the building of cofferdams in a violently fast river with hard rock bottom. They had no Portland cement in those days, and heavy timber boxes filled with stones were used. Still, the first lock was built. It is called Ekeblad Lock, after the chief engineer, and Polhem's lock was all but ready for traffic when the disaster happened. The almost ninety-years-old man had planned the work as a mere youth of sixty! There were no steam engines to assist the workmen, and a faulty step meant sudden death. Still, this survivor from another century dared to do it. Even, when you see Trollhattan to-day with its huge power station, ship canal for sea-going ships, &c., Polhem's lock remains as the greatest wonder of all.

Just five years before his death he finished in 1746 what he called his patriotic testament, which was published in 1761, ten years after his death. On page 57 we find the following:—

"Chap. 14.—ON ROLLING MILLS AND THEIR USE.

". . . Thus a Rolling Mill may squeeze out 10 or 20 bars of hoop iron in the same time as a 'whip-hammer' draws out one bar only, probably more. . . .

"One may also make such rolls which make the knife iron broad and thin towards both edges almost like the shape of ordinary rapier-blades, which, when cut off in the longitudinal direction of the bar, produce good knife blanks and the like. Except for this Rolls may be made for other shapes, such as square, round and half-round bars or rods. Item from steel to all shapes of files. . . ."

On page 117 he also describes as his invention No. 20 the great rolling mill at Stjernsund for plates and bar iron. From this it would seem that he invented and used rolls for profile iron in the first half of the eighteenth century. As Henry Cort of iron-puddling fame, patented the same invention, only in 1783–84, he undoubtedly was anticipated by Polhem. Sven Rinman, in his "Tables to the Science of Mechanics," gives two drawings of rolling mills such as used by Polhem. Both were driven by under-shot water wheels; the last one with two for reversing. I take these notes, &c., from "En Bergsbok till Carl Sahlin," (Stockholm, 1921), otherwise a Book on Mining, dedicated to Carl Sahlin, the great expert on Swedish mining and metallurgical history. With regard to grooved rolls, I may say that wire rolling by hand machines was probably known in Germany centuries earlier, and sheet rolling of iron was done during the Thirty Years' War, but so far no anticipation of Polhem's rolling of profile iron by power has been found. This was only one of his numerous inventions, and one might rightly wonder why he is not more universally known. Still, the solution of the riddle is quite simple; he was a public servant, and his glory belonged to a somewhat jealous government. Secondly, he wrote very few publications, and most contemporary literature about his work is in Latin, like all scientific literature of those days. By a curious coincidence, one of these came by post as I was writing the above sentences, from Stora Kopparberget's library at Falun in Sweden, an original copy of a dissertation *Pro Gradu Philosophico*, by Nauclerus, entitled, "*Delineatio Magnæ Fodinæ Cuprimontanæ*" (Upsala, 1702). This gives a detailed description of Polhem's haulage headgear in Latin, which would have made a Roman weep, but which is easily understood by the tyro. One thing is, however, certain, viz., this and other similar works did not add to popular knowledge of Polhem. He was also unfortunate enough to see Linnæus grow up to monopolise all contemporary fame of Swedish scientific efforts.

Still, maybe Polhem was as much a forerunner of the ultra-modern ideas as Linnæus; he was one of the first engineers in this world with a thorough theoretical training, yet practical to a degree, in spite of his bringing up at *Alma Mater Upsaliensis*. The fact remains that even in Sweden Polhem is to most people only a name of a great engineer, but the whys and wherefores are only hinted at in even fairly pretentious books on Swedish history. In England things are very much the same. How many do, for instance, know the life's work of James Watt? Most people think that he invented the steam engine—which he did not do—and also that he is supposed to have got the idea from a boiling tea-kettle—which is equally fantastic. His great dictum that the steam engine is a *heat* engine, and that its work is proportional to heat quantities, requires too much study to be attractive. I often wonder whether Dr. Johnson did not sum up the fate of all great men in his summary of Charles XII.:

> He left a name at which a world grew pale,
> To point a moral or adorn a tale.

I have had a photographic reproduction made of Nauclerus's excellent drawing and description of the "machina nova." Closer study of the drawing led to the discovery that this machine was far more elaborate and perfect than a cursory glance at the small-scale contemporary drawing would lead one to believe. The reproduction of the drawing is given herewith, and the Latin description, given to the right, reads as follows:—

A, water wheel, the diameter of which is 30ft.

B, axis of rotation with the drum 6 of the second order, provided with pins (lantern wheel). (? *paxillis* mistake for *paxillis*.)

C, transversally toothed wheel engaging drum 6.

D, the axis (axle) of the same, with revolving pin (stud), which moves the rod E and ultimately the arms F connected to it.

G, two rollers with arms I on which the rods H are hung and moved up and down.

H, four hanging rods, each over 200ft. long, and provided with fifteen iron hooks which gradually drag up twenty (?) buckets.

K, two hooked bars which stop the buckets and with the trailing small chain L effect the emptying out of the ore.

M, endless chain hanging on the small wheel N and divided by thirty balls, on which the empty buckets are sent down.

O, two iron forks which strike and release the balls and retard the chain propelled by the empty buckets to a gentle speed and hold the buckets in equilibrium.

P, hanging platform which raises the loaded trucks to the sloping way.

Z, tube emitting water for moving the wheel (overshot).

No description of the catches on the buckets is given, but they must have given way downwards against weights or springs. The use of the four rods H in two pairs makes this machine perfectly balanced as to load and doubly secure compared with similar machines "invented" in Germany during the nineteenth century. As a matter of fact, many conveyors are made to-day which are more cumbersome. That Nauclerus in Chapter II. of his dissertation gives way to somewhat flowery language relating to Polhem is hence not to be wondered at. Curiously enough, the latest historian of Kopparberget, Sven Tunberg, takes objection to this collection of "roseate superlatives" concerning a mere engineer.

THE INSTITUTION OF CIVIL ENGINEERS.

At a meeting of the Manchester and District Association of the Institution of Civil Engineers, held on Wednesday last, December 15th, Mr. H. K. Russell, B.Sc., Assoc. M. Inst. C.E., read a paper on the "New Transit Sheds, Nos. 7 and 9, and No. 9 Dock of the Manchester Ship Canal." The dock referred to is 2500ft. long, and is the largest in Manchester, and the dock walls comprise a series of arches on piers, 6ft. wide, at 25ft. centres, with two superposed subways for cables and grain belts.

The new sheds on the north side rest on piled foundations. The piles go down to rock, and are capped by heavily reinforced concrete blocks. The heavy column loads and the comparative nearness of the rock favoured this type of foundation, as against the pier extension method adopted on the south side. The latter were built in the dry at the same time as the piers. Similar foundations on the north side would have involved working below dock water level, the forming of an unsatisfactory joint between new work and old, and incidentally very heavy excavations, owing to the big increase in the ground level since earlier construction days. Both sheds are of beam and slab construction, with columns at 25ft. by 22ft. centres. Each shed is 450ft. long by 110ft. wide, centre to centre of columns. The height from the ground floor to the first is 17ft. 0½in., and between the upper floors 10ft. 11½in. The roof is stepped back one bay on the dock side, leaving part of the fourth floor uncovered. The first floor is extended on dock and road sides to form loading platforms. The road side platform, in addition, carries one leg of a semi-portal crane, the other leg of which is supported by a deep beam built along the middle of the roadway, and carried on piles driven to rock.

* Newcomen Society, December 15th, 1926.

An Automatic High Precision Screw-cutting Lathe.

THE lathe which we illustrate herewith is an automatic high-precision screw-cutting lathe, designed and constructed by Adam Hilger, Ltd., Rochester-place, Camden-road, London, N.W. 1, for cutting the micrometer and other screws required in optical and similar scientific equipment. The lathe was designed to cut screws of the highest order of accuracy obtainable under commercial conditions; that is to say, the limits set for the tolerance had to be reached without exceeding a prescribed cost of production.

The conditions aimed at for attainment were, first, that the pitch of any thread cut on the lathe should not depart, at a chosen standard temperature—62 deg. Fah.—from the nominal pitch by more than one part in a hundred thousand, and, secondly, that the linear travel of the nut on the screw should correspond to the actual pitch and the number of turns given to the nut or screw to within $\pm$ 0·0005 mm., say, one fifty-thousandth part of an inch. It was stipulated that the second condition was to be realised without the nut being ground on the screw to an extent more than was just necessary to secure a fit between the two.

The lathe as constructed can admit a maximum length of 28in. between its centres and can thread a maximum length of 13in. The maximum diameter of thread which it can cut is 2in. It is not required to cut more than three pitches of thread, namely, $\frac{1}{2}$ mm., 1 mm. and 2 mm., and this limitation was taken advantage of in the design. It was decided to drive the leading screw at a constant speed on the cutting stroke of the carriage and to obtain the variation of pitch by providing three changes of speed for the work. For the 2 mm. pitch the work rotates at 12 revolutions per minute, for the 1 mm. pitch at 24 revolutions, and for the $\frac{1}{2}$ mm. pitch at 48 revolutions.

In the production of high-precision screws it is a common practice to rough out the work on a heavy lathe and to finish it on a lathe of high accuracy. This practice was not followed in the present instance. It was held that it was very desirable to make the tool trace out an accurate screw surface from the start, for it was argued that there was a strong tendency for the tool during the finishing process to follow the cut left by the roughing process, and therefore to perpetuate the errors of the roughing cut.

The cutting speeds, it will be noticed, are very low, the maximum—2in. work at 48 revolutions—not exceeding 26ft. per minute. The sliding feed is also low, being something less than an inch per minute, and the depth of cut taken at each traverse is light. The time taken to finish a screw is therefore considerable, and consequently commercial considerations demanded that the action of the machine should, so far as was reasonably possible, be automatic. It was therefore arranged that after the tool had traversed along the work it should be automatically withdrawn, returned to the starting point and re-engaged for the next cut. It was deemed undesirable to complicate the machine by adding means for automatically stopping it when the thread had been cut to the finished depth. The exact depth of the thread is not a matter of very great importance, not nearly so important as the pitch, for each nut is made to suit its own screw. Consequently, the stopping of the cut could quite safely be left under non-automatic control.

An automatic method of applying the feed had the additional advantage that it permitted the lathe to be housed in an enclosed glass chamber, the temperature within which could be closely regulated, and into which the operator would require to enter only once or twice during the progress of the cutting operations. The chamber is controlled as regards its temperature by a Cambridge Instrument Company's outfit, which keeps the temperature constant to within $\pm$ 0·5 deg. Cent. This fine degree of regulation, we are told, exceeds what is really required, a variation of $\pm$ 5·0 deg. Cent. probably being permissible without causing the limits of accuracy to be influenced.

As an instance of the care given to secure accurate results we may mention that the effect of the cutting forces in compressing or extending the work and the leading screw has been carefully studied. The operation of screwing a thread applies a compressive force to the work, and as a consequence the pitch of the thread after the compression is released is greater than the intended pitch. Again, if the leading screw is held by a collar at the headstock end, the reaction of the traversing stress extends the leading screw between the nut and the collar. This extension increases the pitch of the leading screw, and consequently also the pitch of the thread being cut. Both these influences, it will be seen, tend in the same direction, namely, to increase the pitch of the thread on the work. In the lathe illustrated the two influences have been arranged to act in opposite directions by making the thrust on the leading screw act on a thrust plate at the tail-stock end. In this way the leading screw is subjected to compression instead of tension, and the consequent diminution of its pitch tends to counteract the increase of pitch produced by the compression of the work. The compensation cannot be made complete under all conditions, for complete compensation would demand the preservation of a certain ratio between the cross-sectional areas of the work and the leading screw. All that can be done is to choose the cross section of the leading screw at the most generally suitable value, and to make the tendencies subtractive instead of additive, as in the ordinary lathe.

In the production of the lathe it was decided to make use of a temporary leading screw cut on the most accurate existing lathe and to compensate its errors by means of a correcting bar. When optical methods had shown that the errors of the temporary screw had been compensated to the required extent, the final leading screw would be cut in the lathe itself. A new correcting bar—which ought to be all but straight—would then be inserted in place of the first. This plan of working involved making the lathe longer than was really necessary for the routine length of the work produced on it, but it was held that the advantages of the plan greatly outweighed this small objection.

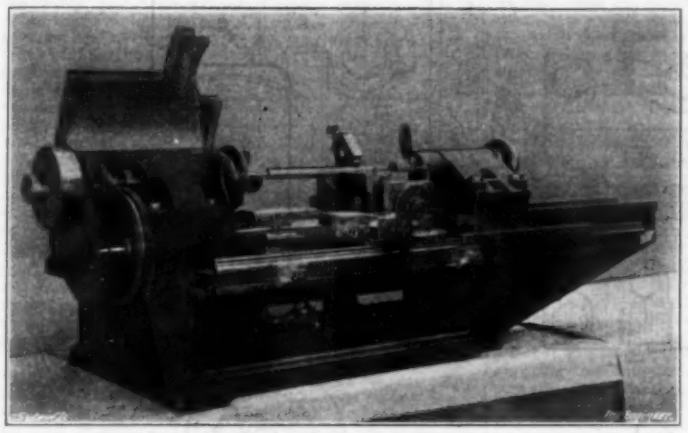
The section of the bed, illustrated in Fig. 4, was chosen of a form facilitating the optical testing of the working surfaces. The top faces of the front and back shears and the edges of the back shear were optically finished—by the Newton's ring method—the surfaces being trued until it was possible to reduce the number of fringes exhibited to four in a length of 10in. The tool carriage is located vertically by the top surfaces of the two shears and horizontally by the edges of the back shear. No horizontal restriction is applied to the carriage at the front shear, the object of locating it solely from the back shear being the avoidance of any possibility of springing the bed by the over-adjustment of the fitting wedge. In addition, the plan resulted in a favourable disposition of the resultant of the cutting and frictional forces.

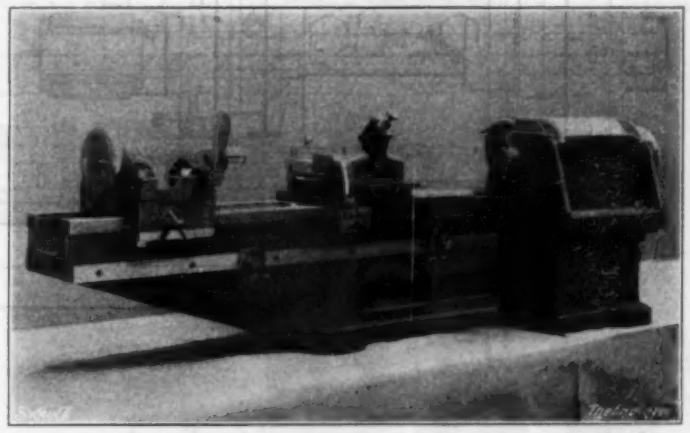
In order to avoid shake in the tool carriage—an essential feature in a lathe of this kind—the nature of the forces acting on the tool during the cutting operations was carefully studied. It was assumed that if the downward component of the force on the tool were taken at 100, the horizontal outward component would be represented by 50, and the horizontal traversing component by 25. The friction of the carriage on the shears was allowed for, the coefficient of friction being taken at about 0·16, corresponding to an inclination of the resultant of 10 deg. By suitably proportioning and disposing the parts, it was arranged that the cutting, frictional and driving forces produced no resultant tending, when a screw of average size was being cut, to twist the carriage in a horizontal plane, to tip it in a longitudinal vertical plane, or to lift it off the front or back shear in a vertical transverse plane.

In accordance with a practice followed in Messrs. Hilger's workshops for over thirty years, the screw to be cut is rotated between centres, both of which are "dead."

In Fig. 5 details of the headstock and tailstock are given. The spindle A is stationary in the headstock, and is bored to receive a tapered dead centre. A face plate B runs on the projecting end of the fixed spindle, and carries three gear wheels which may be meshed separately with a triple gear C, sliding on the driving pulley shaft. The gears C are locked to the driving shaft by means of a screw D, which thrusts a bolt against the side of the key transmitting the driving torque. The locking force is in this way a tangential one, and consequently has no tendency to throw the gear wheels out of truth, and in addition avoids all backlash.

At the other end the driving shaft carries a wheel which is permanently in mesh with a large wheel E mounted on the end of the lead screw. For cutting any one of the three





FIGS. 1 AND 2—FRONT AND REAR VIEWS OF HILGER PRECISION SCREW-CUTTING LATHE

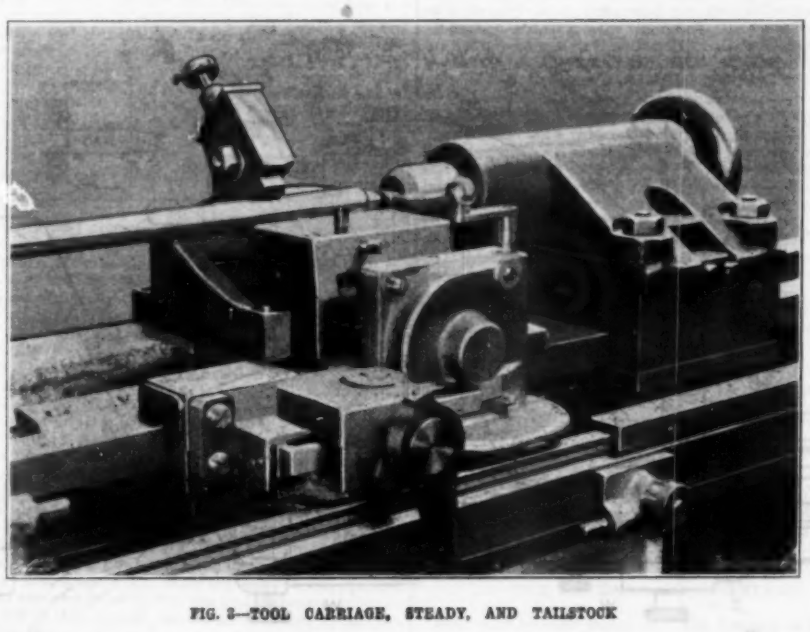


FIG. 3—TOOL CARRIAGE, STEADY, AND TAILSTOCK

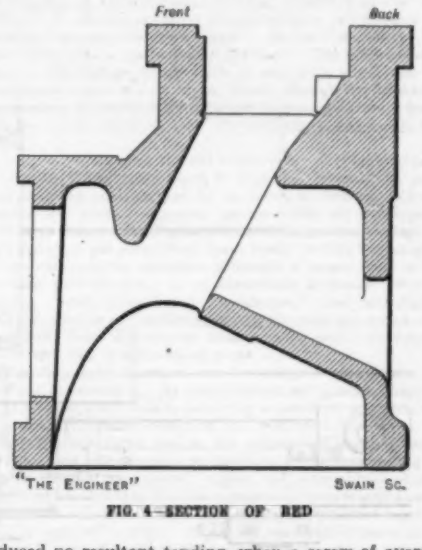


FIG. 4—SECTION OF BED

AUTOMATIC PRECISION SCREW-CUTTING LATHE

ADAM HILGER, LTD., LONDON, ENGINEERS

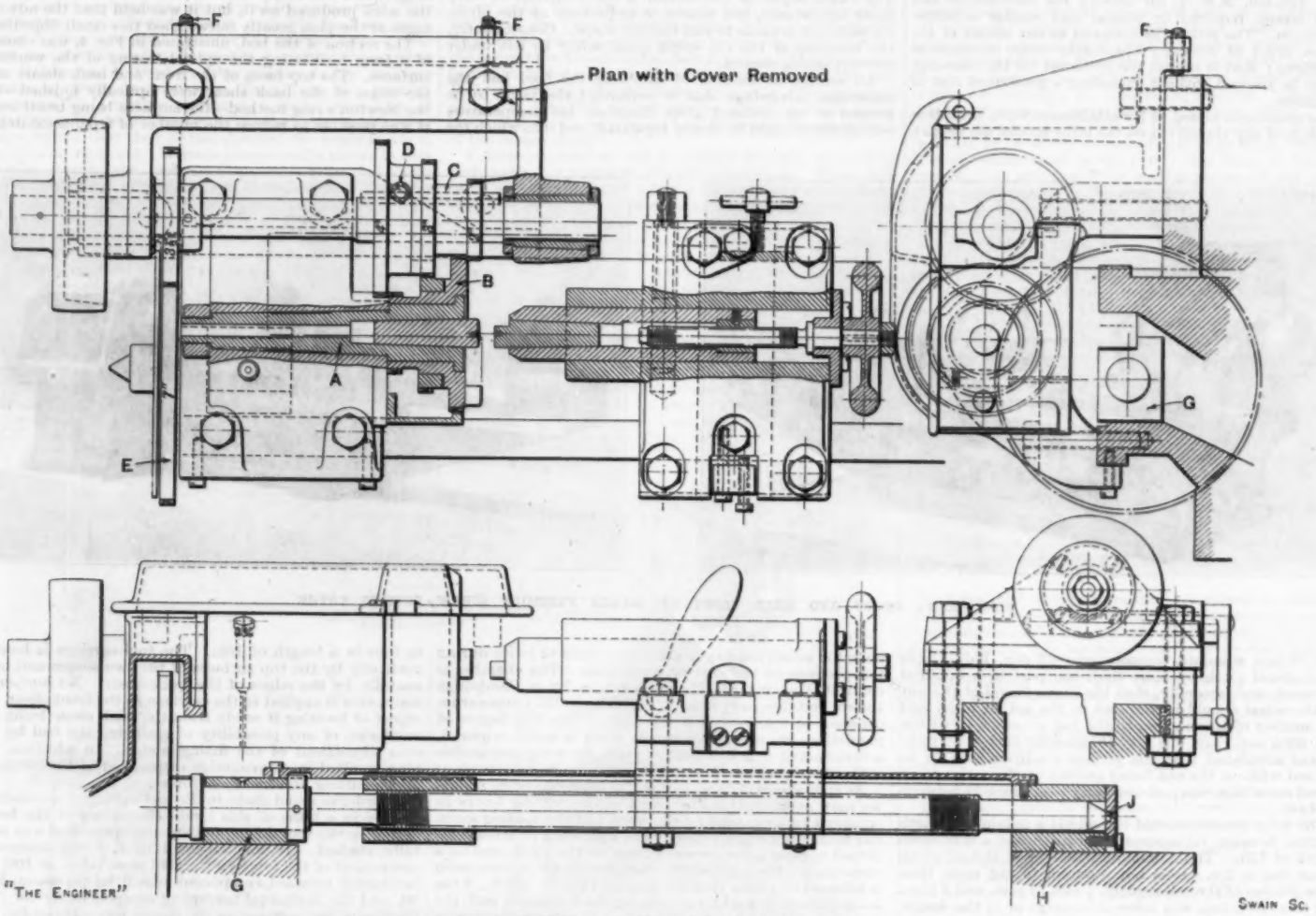


FIG. 5—DETAILS OF HEADSTOCK AND TAILSTOCK

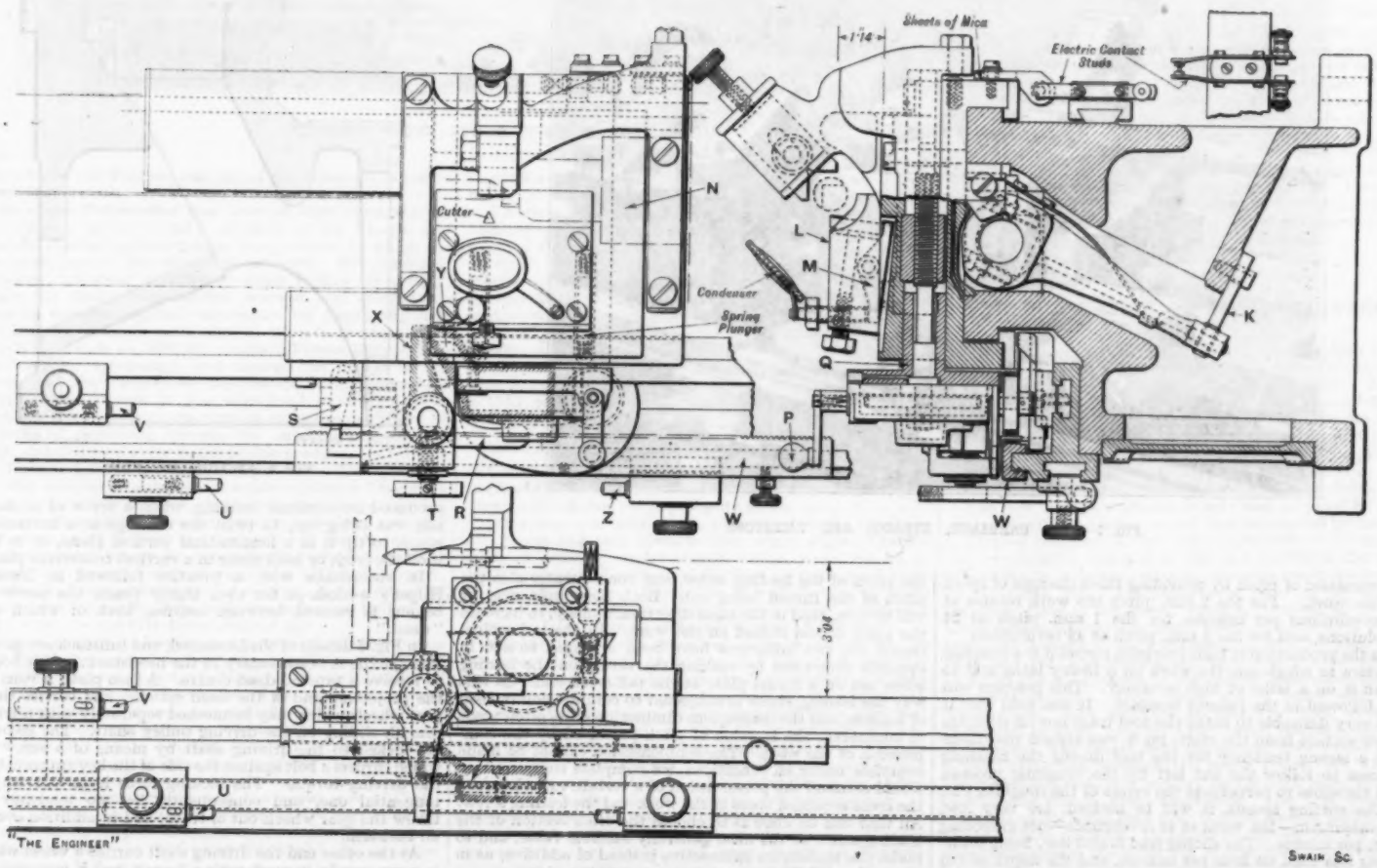


FIG. 6—DETAILS OF TOOL CARRIAGE

pitches there are, it will be seen, only four gear wheels in operation, of which two may be regarded as solid on one spindle. Consequently there are only two points at which backlash can occur in the gearing. The driving shaft is carried in two bearings in a casting which is bolted to the bed, and which is separate from the casting carrying the spindle A. Screws F are provided to adjust the position of the casting carrying the driving shaft in order to effect the proper meshing of the gear wheels.

The leading screw is carried in two bearings G H, which are rectangular in external form and which fit into rectangular slots, machined and ground at one setting, in the bed casting. A guard is fitted between the shears of the bed to protect the whole length of the leading screw and its nut, a slot being left—as shown in Fig. 6—between the guard and the rear shear for the lugs which connect the carriage to the nut. The collars shown on the leading screw on each side of the bearing G—Fig. 5—are free of that bearing. The reaction of the traversing force is, for the reason stated above, taken at the other bearing, in order that the leading screw may be subjected to compression and not tension. At the bearing H the thrust is taken on a small sapphire block J, against which a polished face on the end of the screw bears. The polished face is made strictly at right angles to the axis of the screw, and the accuracy of the bearing between it and the sapphire block is determined by observing through a telescope directed on the block the interference bands between the polished face and the sapphire block, and noting whether any alteration occurs as the screw is rotated. It will be appreciated that if the screw is subjected to other than a strictly axial thrust a relatively large periodic error may be produced in the thread being cut.

The thread of the leading screw, both temporary and final, has an angle of 45 deg. with a flat top and a bottom which is almost sharp. This is also the standard form of thread cut on the machine, for it is the standard form used on micrometer screws in optical instruments. It may here be noted that the thread produced on the work is not "combed" or otherwise touched up after it has been cut. After the roughing and finishing cuts it is untouched except for the grinding of the nut on to it to the extent required to produce a fit. This grinding process, it may perhaps be remarked, consists of running the screw in a lathe and traversing the nut up and down it in the presence of a fine abrasive. Delicacy of feel on the part of the workman quickly detects those portions of the screw on which to concentrate attention.

The nut of the leading screw—as shown in Fig. 6—is made in two pieces, which are screwed together and fits between two lugs depending from the underside of the carriage. The contact between the nut and the lugs is restricted to an area of about 50 square millimetres, the centre of which lies vertically below the cutting point of the tool when work of average size is being operated upon. The leading screw has a diameter of 1in. The nut is 3in. in length and has the thread cleared away over the central third. An arm carrying a roller at its end is cast in one with the lower part of the nut. The roller bears against the edge of a correcting bar, the profile of which, for the temporary leading screw, is determined by applying a divided circle to the end of the leading screw, a microscope to the carriage, a calibrated Invar scale between the dead centres, a micrometer at the end of the arm in place of the roller and a straightedge in place of the correcting bar. For the permanent leading screw the correcting bar should be substantially a straightedge. A spring holds the roller in constant contact with the correcting bar, the function of which is to advance or retard the nut, and consequently the carriage, at those points at which the errors detected in the leading screw call for additional or reduced movement of the carriage.

The cutting tool is in the form of a triangular sectioned bar, and is clamped by a set screw in a very massive tool holder L—Fig. 6. Its top face is ground to lie in the horizontal plane, defined by the centre line of the work. The height of the tool initially and after regrinding is adjusted by means of a set screw and a lever M.

The tool holder is supported on a cross carriage N, to the underside of which is attached a nut working on a cross feed screw. Hand cross feed may be applied to the cross carriage from the handle P, which operates the cross feed screw through a worm and worm wheel. We have, however, already explained that the lathe is designed to operate automatically in order that the necessity for the constant presence of an attendant in its neighbourhood may be avoided. Accordingly, mechanism is applied to effect automatically the disengagement, return, feed and re-engagement of the tool.

The action of the automatic feed mechanism is dependent on the fact that the cross-feed screw is not attached directly to the undercarriage, but is mounted in a slide Q resting within a slot in the undercarriage. A pair of spring plungers exerts a constant pressure on the slide in the direction tending to disengage the tool from the work. During the cutting portion of the cycle the feed screw slide, and therefore the tool, is held in the forward position against a locating face by the pressure of a lever R exerted on the end of the slide. The lever R at its opposite end has, for abutment, a pawl S and at its mid-point is acted upon by a locking screw T. With the pawl in the position shown and the arm attached to the locking screw vertical, or to the left of the vertical, the slide is held firmly against the locating face.

When the tool clears the thread at the end of a traverse, the plunger U releases the locking screw by exerting pressure on its arm. With the screw unlocked the plunger V is enabled to push over the pawl S and so release the lever R. The slide thereupon withdraws under the action of the spring plungers. Immediately thereafter electric contact studs at the back of the bed are pressed together by a stop on the carriage, and as a result an electric belt shifter comes into action. The idle return stroke of the carriage is made with the spindle running at about four times its highest cutting speed, namely, at 200 revolutions. The return motion is transmitted to the carriage through the leading screw, and not from a rack and pinion, for it is essential that the particular contact between the nut and the leading screw established at the beginning of the operation should be preserved unbroken until the work is finished.

At a point during the return motion, the carriage being in the withdrawn position, a pinion on the end of the worm spindle to which the handle P is attached makes contact with an adjustable rack W clamped to the front of the bed. The amount of feed applied to the tool can be varied by adjusting the position of the rack. The return motion ends when an arm X forming a third arm of the lever R strikes an adjustable stop Y. As a result of this action the slide is moved forward into the cutting position, and the pawl S springs back into the position shown. Immediately thereafter the stop Z presses back the lever on the screw T and locks the carriage ready for the next cut. Simultaneously, a second pair of electric contacts at the back of the lathe is closed and the slow-speed forward movement of the carriage is resumed.

While the work is being cut it is supported by a "steady" of very strong construction. The jaw of this steady is adjustable at 45 deg. to the vertical, and the mounting as a whole has a cross adjustment which enables both faces of the jaw to be brought into contact with the work. Since we are dealing with a lathe of super-accuracy, we may raise the question whether it is possible without special precautions to apply a steady to a piece of work in a lathe in such a way that the steady, while preventing the work from deflecting, does not itself deflect the work. If it is applied without much care the pressure it exerts against the work will produce bending, and result in the thread being cut with a smaller pitch than the intended value, the error being a maximum at the mid point of the work. We understand that in the operation of Messrs. Hilger's lathe reliance is placed on the delicacy of the workman's sense of "feel" in the matter of applying the steady without excessive pressure. The work blank is turned parallel before it is inserted in the lathe, and the steady is applied to it at the outset near one of its ends, where it is most rigid. With the work suspended between the dead centres and the driving dog out of action, the workman exercises his sense of feel by turning the blank against the friction of the steady.

When the steady has been set in this manner, it still remains to note that the first cut will throw up a rag, which will result in the pressure of the steady on the work being increased to an unknown and possibly serious amount. It would appear to be beyond human abilities to devise any practical method of cutting soft metals without the creation of a rag. What a serious tribulation the burring of metal under a cutting process may be in certain refined manufacturing systems is well illustrated in the case of the production of matrices for type-composing machines. For an account of the expedients adopted to circumvent the trouble, the reader may turn to our issue of February 20th, 1914, and the two following numbers. In Messrs. Hilger's lathe the trouble is overcome by taking an initial screwing cut along the work without the steady in use. The cut is about one-hundredth of an inch deep, and almost as wide as the finished width between the threads. The rag or burr thrown up is removed and thereafter the steady is applied in the manner already indicated. The steady jaws ride on the flat tops left by the initial relieving cut.

The tailstock—Fig. 5—apart from its extra rugged nature, more or less follows usual practice. It is provided with a cross slide and set screws for adjusting the parallelism of the centres. The clamping of the sliding poppet deserves attention. The arrangement provided is intended to ensure that the resultant of the cutting forces is thrown on to the body casting and not on to the clamping bolt, as in many screw-cutting lathes. The clamp is a draw bolt radiused to fit against the underside of the poppet. The clamping force is exerted almost radially opposite the point of application of the pressure between the poppet and the barrel produced by the resultant cutting force.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE TRAINING OF ENGINEERS.

SIR,—The valuable leader on "The Training of Engineers" in your issue of the 3rd inst. contains much food for thought on a question of the utmost importance.

Foreign competition in the engineering industry appears to be organised on a basis of deadly scientific efficiency. If our industries are to prosper in ap to of this, it can only be by taking full advantage of the scientific training which our universities have to offer.

To attract more of the best-trained brains in the engineering profession to their staffs, our engineering colleges and smaller technical institutes more especially, must offer commensurate salaries. Stress of circumstances does not allow the colleges themselves to improve matters greatly in this direction, but the Parliamentary Grants Committee, and provincial local authorities particularly, could be more liberal in their grants-in-aid.

If the colleges can effect any economy at all, it should be in curtailing the workshop courses, as the practical part of an engineer's training can only properly be gained in the shops of a manufacturing engineer.

It is not encouraging to read that, on grounds of "economy," South Shields Education Committee has withdrawn its annual grant to Armstrong College. This is economy of the worst kind, an example of pound-foolishness which spells danger to our national well-being. W. E. BROOK.

Southend-on-Sea, December 9th.

[Our correspondent is misinformed with regard to the South Shields Education Committee. It has not withdrawn its annual grant to Armstrong College. Its grant for next year will be the same as for this.—ED. THE E.]

AN OLD HYDRAULIC RAM.

SIR,—We enclose herewith a photograph of a very interesting hydraulic ram we recently replaced in Somersetshire. This machine is made entirely of lead, with the exception of the pulse valve, which consisted of a brass flange with a leather clack valve hinged to it, the clack being opened by means of a cast iron weight with an eye formed in the top so that it could be assisted by hand. It is certainly a good example of the plumber's art.

We have been quite unable to trace the maker, but from all we can gather it must have been doing service for the best part of 100 years. We approached Mr. Easton on the subject, as hydraulic rams were introduced into this country by Messrs. Easton and Anderson, but they have no records of any of their machines being made of lead. ROBT. C. GREEN.

Winchester, December 10th.

OLD LEADEN HYDRAULIC RAM AND MODERN RAM

STEAM WAGON DESIGN.

SIR,—The remarks in the issue of THE ENGINEER for December 10th, prefacing a description of the Smithfield Show, raise an interesting, if controversial, problem regarding steam wagon design. In effect you stated that there were two distinct types of steam wagons, the "overtype" and the "undertype," and that there was a distinct field for each. The contractor, you stated, who had to do his work at any price under the worst conditions, chose the overtype, which, though not beautiful in appearance or particularly different in principle from a traction engine, would do work that the undertype was incapable of doing.

I myself think that the old controversy of "undertype" or "overtype" has given place to that of "gears or no gears," and that the position can be re-stated as follows. The contractor-user prefers a geared machine—like all overtypes—so that he can deal with all gradients, and the general haulage man, who does not get away from main roads, prefers the simplicity of the direct-driven machine, although it means that he must sacrifice performance. It is sometimes forgotten when discussing "undertypes" and "overtypes," that, although the greatest number of "undertypes" on the road are direct-driven machines, there are several firms turning out "undertypes" fitted with two or three-speed gear.

The only way in which an "overtype" may score is on grounds of economy. As the cylinders are placed directly on to the boiler shell, steam jacketing is possible, and this tends to economy. If the engine is removed from the boiler there must be some slight loss in the connecting steam pipe, but whether this loss amounts to anything worth considering need not be debated at present. Again, the older school of steam wagon drivers are men who have graduated from traction engines and steam rollers and have naturally a sentimental regard for the "overtype" design. As far as road performance is concerned, I cannot see that the position of the engine matters in the slightest, provided that the axle weights are properly distributed.

Returning to the direct-driven "undertype," I feel that it is carrying simplicity too far when one expects a single-geared machine to tackle every gradient that is met. The hills on the roads in Britain, excellently graded though they may be, cannot be compared with railway track gradients, and the analogy between the direct-driven rail locomotive and a steam wagon can be overdrawn.

No one can question your view that the "undertype" wagon is the more comely, and in my opinion it remains to the two or three-speed "undertype" wagon to oust the "overtype" wagon from the honourable position it has held so long in the transport world. L. W. RIDDELL.

December 13th.

THE output of coal from the mines of Great Britain during the week which ended on December 4th was 3,226,100 tons.

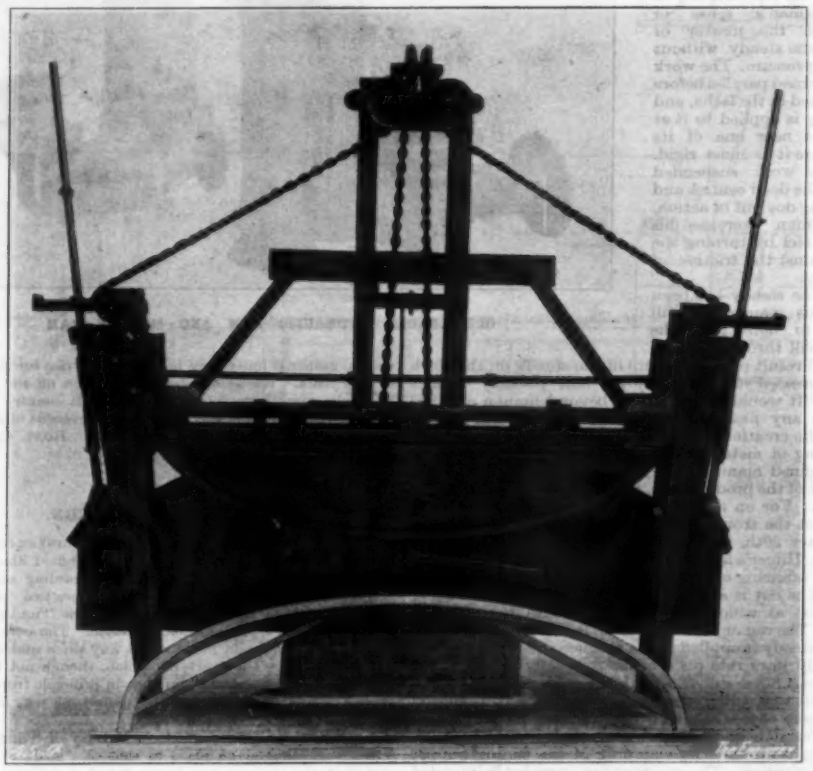
A Roof-stick Bending Machine.

THROUGH the courtesy of Mr. C. B. Collett, chief mechanical engineer of the Great Western Railway, we recently had an opportunity of inspecting at work a machine specially devised for bending the roof-sticks of railway coaches and similar operations. This machine, of which we give an engraving below, is manufactured in America by the J. A. Fay and Egan Company, which is represented in this country by Buck and Hickman, of Whitechapel.

One of the common methods of bending "sticks" in railway coach building shops is to force them down, after appropriate steaming, over steel forms by means of hand-operated cramps, and to leave them in position until they have cooled sufficiently to retain their shape. This process has the double disadvantage that the screwing down of the cramps is very laborious, and must of necessity be made a step at a time, while the whole machine is monopolised until the sticks are stiffened enough by cooling to be taken out again, which generally means that each machine can only effect one bend in a shift, and a number of machines must be installed if any considerable output is required. In the machine which we saw at Swindon, however, successive bendings can be carried out at the rate of about twelve sets of three sticks in every hour, provided, of course, that the steaming kilns can supply the necessary sticks.

The broad principle of the machine is the employment of mechanical power for the bending work, the gradual progress of the bend and the provision of a skeleton mould, on which the bent sticks may be taken out of the machine to be allowed to cool off while another set is being bent.

On reference to the engraving, which illustrates the



MACHINE FOR BENDING RAILWAY CARRIAGE ROOF-STICKS

end of a bending operation, it will be seen that the machine comprises a substantial framing mainly built of wood to which there is attached the former. A pair of bending arms—shown in approximately vertical positions—work in conjunction with the former, and are operated by chains running over the guide pulleys seen at the top of the framing.

When the machine is ready to receive a set of sticks for bending—three are generally bent at one operation—the two arms are lowered into a horizontal position, so that their bottom ends meet at the centre of the former, and their outer ends are supported on two little stools which rise above the floor on either side of the machine. A band of thin steel is attached to the outside ends of both arms, and is of such a length that, when the arms are lying horizontally, it is stretched out flat beneath the former. Above this band there is a second similar strip of steel which is temporarily attached to the ends of the arms, but it is not concerned with the bending operation, and only comes into action when the bent sticks are taken out of the machine, as will be described later.

When the bending arms are in the position just described, the sticks to be bent are drawn from the steaming kiln and are laid on the steel band. They are then clamped up against the former by a simple excentric device worked by the lever plainly shown in the engraving beneath the centre of the former. The bending is effected by a rolling movement of the arms, which is controlled in a rather ingenious manner.

It will be noticed that on the back of each of the bending arms there is a wedge-shaped piece which tapers towards the meeting point of the two arms. These pieces have trough-shaped outer faces, of iron, for the accommodation each of a large ball. The ball is really a globular roller, which is fixed on the end of a radius rod. The two radius rods can be seen reaching up diagonally to a perforated crosshead on the standard, and they are pivoted in this crosshead. The balls can move along the wedge-shaped troughs, but are restricted in the outward direction by springs coiled round the rods, which can be seen extending upward from either bending arm in our engraving. In the retracted position, with the arms lying horizontally, these springs expand and push the balls forward so that the radius rods hang approximately vertically.

Attached to the outer ends of the bending arms there are two chains, which run over guide pulleys at the top of the frame, and then down to a simple winch, driven, in the case under review, by a 7 horse-power electric motor. There are two belts from the motor to the winch, one for working the bending stroke and the other for returning. Both the belts run continuously, and either is put into operation by a friction clutch manipulated by a handle arranged just below the crosshead, at which level it is handy for the operator standing on the pedestal in the front of the machine. The ratios of the belt pulley are such that the return movement is effected at double the speed of the bending stroke.

When the bending process is first started by drawing in the chains, the arms rapidly take up an angular position, and the steel band is pulled tightly against the crown of the inverted arch sticks, which starts the bend round the easy part of the curve. As the resistance to bending increases the springs holding the ball rollers are compressed and progressively resist the outward movement of the rollers, so that the radius rods hold the bending arms in towards the form, and exact an increasing pressure on the sticks to be bent. Finally, at the end of the bend the pull of the chains and that of the radius rods are almost in line to complete the sharp curve at the haunches of the arch.

While the machine is in this position, a horizontal tie rod is fixed between the two ends of the loose steel band next to the bent sticks. In the illustration this tie-rod can be seen just above the former, and it will be noticed that it is perforated throughout its length. As a matter of fact, the rod is in two pieces, and the holes are set at a different pitch in each half, so that a fine adjustment of the total length of the tie can be effected. It will also be seen that the former is made in two distinct pieces, of which the upper section is portable. This upper piece is held down to the main former by a pair of straps, and rests on two step-shaped distance pieces, so that there is a slight gap between it and the main former. When the bend is finished the straps are opened, and the distance pieces are pulled forward. There is then sufficient clearance between the two parts of the former to separate them. The lower half remains fixed to the machine, and the upper piece, acting as a strut to resist the tension in the tie bar with the bent sticks, is taken away. The loose steel band naturally accompanies the bunch of sticks and holds them in shape. It is then only necessary to run the bending arms back to the horizontal position, insert a new steel band and the top section of the former to be ready for another bending operation.

As the sticks are taken from the machine they are laid down and left to cool for several hours. The tie bar is then freed, and the sticks are released from the band, but each one is immediately roughly stayed, like the one shown on the floor in the engraving, to keep them in shape while they are in store until required.

The nominal speed of the machine is half a minute for the bending operation and a quarter of a minute to return, and we noticed that the whole cycle, from starting to charge the machine to the withdrawal of the bent sticks, occupied five minutes. On this occasion three sticks each 2¼in. by 3in. by 10ft. 6in. were bent in a bunch, and, as will be readily understood, the greater part of the time was accounted for in drawing the sticks from the kiln and setting them in place in the bending machine. It is hardly necessary, in conclusion, to mention that the former may be of practically any shape and dimensions within the capacity of the machine.

South African Engineering Notes.

Boring for Oil.

At the present time prospecting for oil in South Africa is being conducted on a large scale, though so far no "gusher" or, indeed, any other oil well has been discovered. There are, however, three districts where indications are considered to be favourable, and geologists of repute have stated that they consider the chances of success are good. In two of the three districts the opinions of the South African geologists have been confirmed by oil geologists lately in the service of the Royal Dutch Shell Company. One of the occurrences is believed to exist in the portion of South-West Africa which was German territory prior to the war, but is now mandated territory administered by the Union of South Africa. At the spots indicated by the geologists bore-holes are being put down, and already a large fathomage has been accomplished. The oil is believed to be at a depth between 2000ft. and 3000ft. Another company is undertaking boring operations at Inyaminga, just on the border between Northern Rhodesia and Portuguese territory. American percussion drills of the latest type, for 12in. bore-holes at starting, are being obtained. A third occurrence is believed to be situated on the farm Gruisfontein, near Devon Station on the Ermelo Railway line in the Transvaal. In this case there is something tangible, as far as it goes. For fifteen years large volumes of gas have been uninterruptedly flowing from some bore-holes which were put down at that time. The bore-hole at which operations were suspended some fifteen years ago, owing to the rush of gas, was then covered with concrete, but the gas still escapes. Both gas experts and geological authorities, who have been for some time past investigating the occurrence, believe that there is oil in the depths. Indeed, the experts are expecting to find that the gas is associated with a huge reservoir of oil. The Devon Petroleum Prospecting Syndicate, Ltd., has been formed, and is inviting tenders for drilling and casing several bore-holes. The rotary system of drilling will be employed. The casing required will vary in outside diameter from 7in. to 13in. If the expectations of its promoters are realised, the Gruisfontein occurrence has very considerable potentialities; but in view of the many bore-holes that have been put down from time to time at what were represented by geologists and oil experts to be promising spots with no result, some tangible results will be required before any particular enthusiasm will be aroused by the present venture.

Mishap at a Gold Mine.

A very serious accident occurred in the engine-house of the main vertical shaft of the Luipaardsvlei Estate Gold Mine, near Krugersdorp, Transvaal, on October 11th, owing to the rope of a skip splitting. Considerable damage, estimated at £7000, was caused, but there was no loss of life. There were 900 boys underground at the time. Two years previously, and at the same period of the year within a few days, a fire occurred in the crusher house of this mill, and the mine headgear was also destroyed, with the result that the mine was stopped for months while repairs were effected.

Witbank Power Station.

Two of the three 20,000-kilowatt generators at the Witbank (Transvaal) power station were in commercial service before the end of October, and the third had been tested successfully under full load. It is expected that the whole station will be at work by the end of the year. It is considered likely that when the station is in full operation the price of ·442d. at which it was estimated that power would be supplied to the mines, will be further reduced, and it is even being hoped that it will be brought below the level of the great water power installations in some parts of America and Europe. The consumption of coal by the station will be about 400,000 tons per annum. The Rand-Witbank chain of power producing stations of which the Witbank is a unit, is the largest steam generating power undertaking in the British Empire. The total capacity of the system when the third set is in operation at Witbank, and including air compressors, will be 398,000 horse-power. The main factors in bringing down the cost per unit are that the station has a market for its total output; is built on a coalfield, and can utilise "duff" as fuel, the cost of which, under the contract made, is 1s. 9d. per ton. The station will cost about £1,250,000 when completed, and in addition a sum of about £300,000 has been spent on the power transmission lines, and the great 100ft. high masts which straddle the veld. The construction of the station has been rapid, the first machine running within eleven months of the arrival of the first building material on the site. A party of members of both Houses of Parliament inspected the station, and also the coal mines in the Witbank district on October 14th.

Motor Assembling.

The growth of the motor car assembling industry in Port Elizabeth, which has been selected as the centre for the Union, bids fair to become remarkable. About the middle of October the General Motors Corporation, the assembly factory of which, with its equipment, &c., cost between £300,000 and £400,000, was only put in commission a little over three months ago, announced the completion of the thousandth Chevrolet car to be assembled locally. The General Motors Corporation, it is stated, has already found it necessary to embark on extensive factory extensions. The Ford Company, which was the first to erect an assembly factory in South Africa, also at Port Elizabeth, contemplates the early erection of a complete new factory building, where the manufacturing processes at present in operation will be greatly added to. Although with no such facilities in South Africa, British manufacturers of motor cars have no reason to be dissatisfied with their progress during the last three or four years. During 1923, 275 British cars were imported into the Union, the value being £90,283; in 1924, 722 cars,

worth £195,795, were imported; and in 1925 the number was 1613 and the value £358,245. As far as the percentage is concerned, this increase was only beaten by Germany, which country supplied the Union in 1924 with 158 cars, worth £25,486, against 54 cars worth £7403 in 1923. By far the greatest numerical increase was in American-made cars, which increased from 7181 cars, valued at £1,480,787, in 1924, to 10,560 cars, valued at £2,020,565, in 1925. As motor cars are about the only article in which British manufacturers are not losing ground in the Union market, they will do well to follow their competitors' example, and establish an assembling factory, or they will find themselves heavily handicapped.

MANCHESTER ASSOCIATION OF ENGINEERS.

A PAPER on "Rubber and its Application to Engineering," by Messrs. H. P. Stevens, M.A., and B. D. Porritt, M.Sc., was read at the meeting of the Manchester Association of Engineers, held at the Engineers' Club, Manchester, on Friday, December 10th. In their paper the authors dealt principally with the handling of the raw material, the vulcanisation process and the methods of compounding various substances to give the desired properties to the finished product. Thus, the tread of a motor tire, for instance, was stated to consist of 60 per cent. rubber, 20 per cent. carbon black, 10 per cent. zinc oxide, and the remaining 10 per cent. sulphur and other ingredients. The compounding is influenced largely by the price paid for the rubber. In cheaper rubbers refined china clay is a constituent, which has useful qualities. Whiting and French chalk are of less value, but substances of large particle size, such as ground barytes, are of less value still. The rubber manufacturer had at his disposal means of qualifying the properties of rubber to such an extent that he could supply engineers with products to suit their particular requirements. That, the authors stated, was not always understood by engineers, who although familiar with many articles made of rubber which were in daily use in this branch of industry, did not always realise that rubber might be used in place of a number of other materials. As an instance, the application of rubber as a buffer material for damping shocks was mentioned. The employment of rubber in the manufacture of articles which are rigid, although still elastic, was also referred to. As an illustration, ebonite and vulcanite were given. The authors state that nowadays, as a result of chemical research, the manufacturer with the aid of "accelerators" obtained a greater range of vulcanising conditions, as well as a shortening of the process or lowering the temperature, together with a reduction in the proportion of sulphur. All these tended to stabilise the vulcanised rubber, while more recently still there had appeared on the market chemical substances the function of which was to prevent decomposition of the vulcanised product should the safe limit be exceeded. Tests published by the makers showed clearly that that result was obtained, as specimens of vulcanised rubber containing the stabiliser stand up much better under artificial ageing tests than control specimens.

CONTRACTS.

THE GENERAL ELECTRIC COMPANY, Ltd., of Magnet House, Kingsway, W.C. 2, has received orders from the Admiralty for 200,000 Osram gas filled and vacuum lamps, and 15,000 special Robertson carbon filament lamps.

STOTHERT AND PITT, Ltd., of Bath, have been instructed by the Great Western Railway to install at the new goods station at Templemeads, Bristol, twenty-five electric capstans for three-phase alternating current, of the free-head type, each to exert a pull of 1½ tons at a hauling speed of 200ft. per minute.

KEK, Ltd., of Aldwych House, London, W.C. 2, has received orders for grinding and blending mills for use in various parts of the world for the following purposes:—Sugar manufacture (Australia), magnesite works (Italy), chemical works (South America), soap works (Spain), colour works (Great Britain), malsters (Great Britain), paint works (Great Britain), grinding fine chemicals (Great Britain), grinding biscuit filling material (Great Britain), and chemical works (Holland).

THE Brown-Boveri organisation has received from the Berlin Metropolitan Railways an order for (*a*) Ninety-five rectifier equipments, each for an output of 1200 kilowatts, making a total of 114,000 kilowatts; (*b*) ninety-five rectifier transformers, each for 2000 kilovolt-ampères; and (*c*) 160 high-speed direct-current circuit breakers, each for 3000 ampères. Each rectifier unit is to have a normal current rating of 1500 amperes at 800 volts, but as the overloads to be carried are exceptionally high, owing to the 90-second train service that will be maintained, the load that has to be provided will be 3000 ampères for 40 seconds, followed by 300 ampères for 50 seconds, this cycle being repeated every 90 seconds.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY has received an order for an electric winder of 1130 horse-power r.m.s. rating, capable of exerting a maximum peak of 2800 horse-power from James and Alex. Brown, of Richmond Main Collieries, New South Wales. It is to be installed at a new shaft at Stockrington Pit, near Newcastle, and is to lift a net load of 6 tons from a depth of 920ft., with an output of 400 tons per hour. The set will be controlled on the Ward Leonard system and the main motor, operating at 39·7 revolutions per minute, will be direct coupled to a 13ft. cylindrical drum. Power for the main motor will be supplied by a motor generator set consisting of an induction motor of 620 horse-power at 1000 revolutions per minute, driving a 790-kilowatt direct-current generator with a fly-wheel of 6½ tons.

WORTHINGTON-SIMPSON, Ltd., Newark-on-Trent and Queen's House, Kingsway, London, have received an order from the North British Locomotive Company, Ltd., for twenty No. 2132 Worthington locomotive feed-water heaters and boiler feed pumps, each capable of delivering 3200 gallons per hour. These are to be fitted to the twenty 2–8–4 type side-tank locomotives built by the North British Locomotive Company, Ltd., for the Antofogasta and Bolivia Railway Company. The Worthington-Simpson Company has also received an order to supply a 7in. four-stage vertical bore-hole centrifugal pump driven through helical bevel gearing by a two-cylinder oil engine for the Ford pumping station of the Herne Bay Waterworks. The capacity of the pump will be 650,000 gallons per day, delivering against a total head of 310ft. The same firm has also received an order to supply the complete surface condensing plant required for the power extensions of the Leicestershire and Warwickshire Electric Power Company, Spondon power station, the plant to include a 15,000 square feet surface condenser with steam jet air ejectors, pumps, motors and heater for a 12,500-kilowatt turbo-alternator plant.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

WE are so near to Christmas that in the basic industries of the Midlands and Staffordshire a quiet time must be anticipated for the time being. There has been no demand to speak of this week, consumers of iron and steel attending only to immediate needs, and adopting a waiting policy with regard to purchases for the renewal of activities after the holidays. Values are irregular, and so much depends upon fuel costs which continue to weaken that it is argued that buying is likely to be much more profitably undertaken at a later date. In this area more re-rolling concerns have come into operation and increased supplies of ordinary bars, flats and material of this type are helping a large number of trades in Birmingham and elsewhere. Till the blast-furnaces get going again, however, industry will be unable to find its feet, for there is no foundation on which to build. There is nothing stable about the market. Prices move irregularly, and there is no disposition on the part of anyone to place forward contracts. In all branches of production and manufacture there is an accumulation of orders awaiting execution, and numerous inquiries which lead to the assumption that the outlook for the New Year is good.

Staffordshire Iron Trade.

Business is certainly improving in the Staffordshire finished iron trade. Quite a number of puddling furnaces in the Black Country have been re-started, and wrought iron is once more a marketable commodity. The new basis fixed for marked bars, viz., £14 10s. is low in comparison with the price which Crown bars are making. The readjustment in marked bar prices has been made on the faith of a more pronounced reduction in fuel than has yet been effected; 10s. a ton is stated to be less than half the rise in the net selling prices ascertained under the Midland Wages Board's sliding scale. Lancashire mills are competing keenly with those of Staffordshire for the trade in Crown and lower grade bars. Staffordshire Crown quality bars were this week offered at £12 15s., or 5s. per ton less than was quoted a week ago. Lancashire houses, however, now offer supplies at £12 12s. 6d. Second quality bars can be bought at £11 5s. for 50 or 60-ton lots. Thick wide strip is coming forward for the tube trade at £8 12s. 6d. to £8 15s., while for working-up strip £11 10s. is the price. No. 3 Belgian bars for which there is a regular inquiry are quoted £6 14s. Staffordshire ironmasters are making every effort to get their forges and mills to work. For the first time since May, the whole of the mills at Messrs. N. Hingley's large ironworks at Netherton and Old Hill have been restarted this week, and it is understood they will be fully employed until Christmas. It is agreed that a good deal of iron production will be unprofitable at the present price of coal, and a demand is made for a further cut of at least 10s. per ton in works coals. The resumption of activity is chiefly on the finishing side of the business, mills getting to work well ahead of the steel furnaces and blast-furnaces. Shortage of railway wagons is proving a great handicap to manufacturers, and they are experiencing difficulty in the transport of their goods through this cause. Plentiful supplies of fuel are now being obtained, but pig iron is very scarce.

Pig Iron.

The pig iron position is improving, but blast-furnacemen are moving but slowly. Welcome, though limited, supplies of Derbyshire foundry are now reaching the Birmingham district. Two furnaces at Staveley and the few that are in blast in Cleveland and adjacent districts are the only home scoures of supply. It is reported that another Derbyshire furnace is to be restarted. It is doubtful, however, if Midland smelters generally will be able to give supplies of iron this year. Several instances are reported of preparations being made for an early start after the holidays, and substantial augmentation of the home supply of pig iron may be expected early in the New Year. This week Cleveland pig has been offered for January–February delivery at £4 5s. for No. 3 foundry, as compared with £6 quoted a week ago, and a current quotation of £5 12s. 6d. at furnaces. For Derbyshire No. 3 foundry £4 12s. 6d. at furnaces is still quoted. This is equivalent to £5 delivered Birmingham. Lincolnshire material is on offer at a trifle more. The output of the furnaces now operating is said to be committed over the first two months of next year. The market is still very largely dependent upon continental material. The blast-furnaceman's chief trouble is the high cost of and difficulty in securing suitable fuel. Coal and slack is reported to be more plentiful, but complaints are prevalent as to belated deliveries, owing to congestion on the railways. Blast-furnace coke is scarce and dear. Moreover, it is not obtainable in sufficient quantity to give smelters a sense of security as regards the continuity of supplies. The prices quoted for the small lots available are more than furnacemen can contemplate as the basis of a renewal of trade. Cokeries are being brought into activity again only very gradually, a deterrent being the comparatively high prices that can still be obtained for coking fuels for uses other than those to which they are normally applied. It looks as if coke prices will take some time to crystallise. Meanwhile, smelters must either make the best bargains they can or defer plans for putting their plant into operation again. Most of them appear to accept this alternative.

Steel.

The steel trade continues quiet, but it is understood that some of the big plants will be got into operation after the Christmas holidays. So far as new business is concerned, the steel works still maintain a waiting policy in the absence of information as to cost of fuel. Big steel is very difficult to buy, the mills producing joists, plates, sections, &c., being dependent on their steel furnaces, and to some extent on blast-furnaces. A number of steel furnaces have, however, started in the Dudley district. The works have plenty of orders, with much more in prospect when prices can be definitely stated. Values continue very irregular and difficult to determine, transactions being influenced by individual circumstances. Until after the Christmas vacation there is no promise of steel in any volume. Billets and blooms are unavailable from home sources; some high carbon billets are, however, expected shortly. The price is £9 2s. 6d., or £1 more than at the time of the stoppage. Midland re-rollers are almost wholly dependent upon imported billets, chiefly French. Very little German semi-finished material is reaching the Midlands. Common grade continental billets are quoted at about £6 5s. to £6 6s. Demand has abated somewhat after a period of stimulated activity. Imported steel sheet bars are £6 7s. 6d., about 5s. below the peak price. South Wales bars are scarcely obtainable on this market as yet. Forward business in all-English wire rods can be placed at £10 5s. for lots of 10 tons and over, and rods rolled from continental billets fetch £9. Substantial orders have been placed for foreign semis, on the assumption that prices of finished steel are likely to be sustained by the strength of demand at a moderately high level for some little time to come. It is anticipated there will be a very good demand for native constructional material as soon as it can be produced.

Galvanised Sheets.

The output of galvanised sheets has been considerably increased of late, and values have fallen further, 24 gauge corrugateds being procurable on 'Change in Birmingham to-day at £17 per ton, 5s. per ton below last week's minimum. Business both on home and export account is quiet, and is expected to remain so until the New Year.

Welded Turbine Casings.

Thompson Brothers (Bilston), Ltd., of Bradley Engineering Works, have recently completed the steel casings of the four turbines for harnessing the Falls of Clyde. These casings have no rivets or bolts, the whole being electrically welded.

New Miners' Union.

The movement for the formation of a new miners' Union for Derbyshire, to be free entirely of party politics, has been advanced this week by the appointment of officers. A commencement will, I am given to understand, be made in the Alfreton coalfield, where, with the consent of the members, owners are being asked to deduct 1s. per week from wages. Out of this, 6d. will be earmarked and funded for old-age pensions and for allowance for miners permanently disabled. A meeting of the Council of the recently formed Nottinghamshire and District Miners' Industrial Union has been held and a constitution formulated. Notts. coalowners at a joint conference with the miners' representatives approved in principle of the new non-political trade union for the men, and have decided to appoint a sub-committee to consider the actuarial soundness of funding 6d. per week per member for the provision of old-age pensions. With a view to their contributing to the fund, it is suggested that the owners should be represented on the Board of Control of this part of the union's work, which is to be separate from the ordinary industrial part.

Wolverhampton Scheme.

A comprehensive scheme, embracing new abattoirs, meat market, cold stores, ice factory and waste-eliminating plant, at an estimated cost of £70,000 was outlined in a report of the Markets Committee submitted this week to the Wolverhampton Council. The report pointed out that in recent years special plant has been devised to utilise waste products, and instead of expense being incurred in their removal, it has been found possible to manufacture valuable by-products, such as blood manure, meatmeal, bonemeal, fats, &c., for which there is a growing demand, and market them at prices which make the undertaking remunerative. The Committee recommended the installation of a waste-eliminating plant, being satisfied that it would prove of great service and a source of revenue, and the Council adopted the recommendation.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

A Change of Bridges.

A SMART piece of work was carried out last Sunday morning, when a change of railway bridges was effected in a matter of five hours. A new bridge with a span of 48ft. and weighing about 150 tons, constructed by Pearson and Knowles, Ltd., Warrington, was designed to replace one constructed in 1867 to cross the railway lines from Manchester Central Station across the Barton-road between Trafford Park Station and Urmston Station on the Cheshire Lines system. At four o'clock on Sunday morning the task of removing the old bridge was begun, and by 9 a.m. the new structure was in position. The new bridge is made entirely of steel, and the road when completed will be about four yards wider than formerly. The alteration had been necessitated by the growth of vehicular traffic, which is now particularly heavy at the point in question. Both the up and down lines were blocked whilst the work was in progress, and the local services were suspended.

X-raying Solid Bodies.

Sir William Bragg discussed the method of X-ray analysis of solid bodies in his "Ludwig Mond" lecture at Manchester University. He remarked that as a result of this method scientists now stand on the threshold of a new sphere of inquiry which might lead to discoveries of momentous importance to industry and to applied

science. By means of X-rays directed on to solid bodies it was possible, he explained, to obtain photographic negatives which provided important evidence as to the atomic structure of these solids. The answer to the question of what gave the engineer the power of building bridges was obviously concerned with atomic structure, and a science which could explain the nature of solid bodies in terms of the atoms of which they were built would, said Sir William, be a science running parallel with the science of chemistry, although it would cover entirely new ground.

Ford's Five-day Week.

An experiment with a five-day working week of forty hours, in place of the previous forty-four hour week, has been started at the Ford Motor Company's Trafford Park Works, Manchester. Altogether there are about 2000 people employed in the works, at a minimum wage of £6 12s. a week, the fifty or sixty women who are employed as typists or in other departments being paid on the same scale. Under the new scheme the employees work from eight o'clock in the morning until 4.30 in the afternoon, with a mid-day interval of half an hour. The theory put forward by the management is that it believes it can secure the same output, if not more, in the reduced number of hours, and at the same time effect certain economies in overhead charges. Apart from a process of speeding up, other factors which will come into play are the elimination of waste, the improvement of machinery, and the careful adaptation of the works organisation to the new conditions.

Disposal of Steam Wagon Business.

It is officially announced that Leyland Motors, Ltd., of Leyland, near Preston, has disposed of the steam wagon portion of its business to the Atkinson Walker Company, of Frenchwood Works, Preston, which will take over all existing stocks of components and units. Inquiries for spare parts and replacements for Leyland steam wagons should now be addressed to the Atkinson Walker Company.

Non-ferrous Metals.

There has been an absence of any marked activity in virtually all sections of the non-ferrous metal market during the past week. Tin has lost a good deal of ground on balance, and as there is little expectation of improved buying conditions during the remainder of the present year, a recovery in this section of the market may be delayed. Much of the buying in the case of copper was of a speculative nature, industrial consumers still operating sparingly, although the turnover of the metal was sufficient to effect a slight improvement in values compared with a week ago. The statistical position of spelter is regarded favourably, and largely on the strength of it, prices have kept steady almost throughout the week. There has been only a moderate amount of trade buying of lead but holders of this metal are pretty firm, with the result that a slight advance in the level of quotations has taken place.

Iron.

Although developments on the production side are foreshadowed to take place early next month, there has been little actual change in the position of supplies of pig iron as compared with any of the two preceding weeks. There seems to be a fairly confident feeling that by that time coke prices will have fallen to a more favourable level than they have at present. It is more than likely, however, that during the next two months the supply position will remain difficult, although, of course, a gradual improvement will be witnessed. The one Derbyshire firm that has had two furnaces at work for a fortnight or three weeks has its output earmarked for the remainder of the present month and throughout January, and is now quoting at 7s. 6d. lower for February delivery on the basis of 85s. per ton, on rails at the furnaces, for No. 3 iron. Another concern is now quoting for January and February delivery at 92s. 6d. at the furnaces, or 100s. 9d. per ton delivered into this district. Scottish and Middlesbrough makers for forward delivery are quoting 115s. to 120s. per ton and about 100s. per ton respectively. These offers are meeting with a fair response, although there is very much less anxiety to take up the small parcels that are being quoted for prompt delivery at premium prices, Middlesbrough being offered at about 127s. per ton and Scottish at 132s. 6d. Up to 105s. per ton, delivered Manchester, is being asked for West Coast hematite on forward account. Manufactured iron remains quiet, but values keep steady at £12 10s. per ton for Crown bars, and £11 5s. for second qualities.

Steel.

During the past week there has been a further slight easing in certain sections of the market for continental steels, and the demand for this material is still on the quiet scale of the last few weeks. For delivery to buyers' works in the Manchester area, for cash against shipping documents, sheet bars are now quoted at £6 5s. to £6 7s. 6d., billets at £6 to £6 2s. 6d., steel bars at £6 12s. 6d., joists and sections at £6 12s. 6d. to £6 15s., Siemens' plates at £7 15s., and light plates at £7 7s. 6d. to £7 10s. Orders placed several months ago have been arriving at Ship Canal ports during the past week, and with delivery delays still serious, fresh business remains slow in coming forward. There has been little or no improvement in supplies of British steels, and few rolling mills will now start before about the middle of January. In all sections prices are well maintained, with boiler plates at £11 10s. to £11 15s. per ton, delivered Manchester, tank plates at £8 17s. 6d. to £9, joists and sections at £8 to £8 5s., basic steel bars at £9 to £9 5s., and basic wired billets at £9 5s., and acid billets at £10 10s. delivered. Inquiry is fair in some sections of the market, but actual business at the moment is quiet. Re-rolled steel bars are fairly steady at £9 5s. to £9 10s. per ton, but there is not a great deal of demand for them. The Indian demand for galvanised sheets keeps surprisingly slow, and prices have displayed a weaker tendency during the past few days, with the usual Bombay or Calcutta specifications now offered at £16 10s. to £16 15s. per ton f.o.b.

Scrap.

Although there has been no actual improvement in the buying of non-ferrous metal scrap, inquiry has been rather better. Prices generally are steady, with brass rod turnings on offer at about £40 per ton, selected gun-metal at £52, clean light copper at £56, brazierv copper at £52, zinc at £25, and lead at £28 10s. per ton, for sorted qualities, delivered to users' works.

BARROW-IN-FURNESS.

Hematite.

Preparations are proceeding for the restarting of the various works, but there does not appear to be any undue haste. There are two reasons for this, the close proximity of the holidays and the hesitation to rush in and purchase fuel before it becomes quite normal again. Now that the mines are freed from all restrictions the supply and the price will soon become favourable to the iron producers. One company in its annual report says that the orders it holds are larger than has been the case for several years, and that both its works and mines are assured of a good run of work. This state of things applies to practically the whole of the makers, and amongst the orders is a fair percentage for higher grade iron of special quality. The market is quiet and will remain so until deliveries have been made and repeat orders are placed. It is difficult to say what the American and continental trade will be at present.

Iron Ore.

The iron ore industry is simply waiting for the putting into blast of the furnaces, when it will enter upon a better period than it has experienced for many years. It is hoped and believed that there will be a better trade in native ores outside the district than there was in the early part of the year. Probably business with Scottish buyers will be better. Foreign ores will soon be arriving. Vessels will take out export coal and return with ore in a great many cases.

Steel.

There are sufficient orders for steel to keep the works engaged for about six months, and it is hoped that as soon as the mills are running and the Siemens' furnaces are at work again, the market will improve.

SHEFFIELD.

(From our own Correspondent.)

Towards Resumption.

SOME progress has now been made towards the resumption of steel production, and there is a likelihood of good supplies of material being available for the manufacturers by the opening of the New Year. Two blast-furnaces are working at Staveley. One of the largest open-hearth steel plants in the district is that of the United Steel Companies, which are restarting production on a considerable scale. They have brought some furnaces into operation already, and they expect to have eight working by the end of next week. At Stocksbridge, Messrs. Samuel Fox and Co., who have two furnaces working, are starting a third. Several Sheffield firms are melting steel for their own requirements. There has been a sharp fall in the price of coal, which is now to be obtained at not much more than pre-strike rates. The withdrawal of the embargo on coal exports, however, is not welcomed by steel makers, as this extension of the market has had a tendency to stiffen prices. Coke has not fallen to anything like the same extent as coal, and the blast-furnace owners are having to pay much more than the normal 18s. or 19s. per ton. The bulk of the blast-furnaces catering for this district will not be ready for work until the New Year. The quotations for pig iron, to be delivered after the resumption, run at about 15s. per ton in advance of the old prices.

Manufacturing and Lighter Sides.

So far, there is not much improvement to report in the condition of the manufacturing side of the steel trade. A very considerable amount of activity has been maintained throughout the coal dispute, and this is expected to show an increase when full supplies of raw material are available, but for the present there is not much change. A good many suspended orders are on hand, but new business is falling off with the approach of the year end. The crucible steel trade is now able to obtain home supplies of the special coke used for melting its product, but prices remain high. For beehive coke, which is preferred for the melting of the highest grades of steel, 70s. per ton is being asked, as compared with 35s. before the strike. The steel makers have still in stock a good deal of the Westphalian coke which they have been buying during the past few months.

Cutlery and Plate.

Many shopkeepers appear to be experiencing a better Christmas demand for cutlery and plate than they expected, and as a consequence there has been an increased activity in the trades during the past week, a good many small orders having come in for immediate execution. These relate largely to the cheap lines, one or two makers of which are working overtime. Cheap lines in cases, for gift purposes, are very much in favour with the public. For expensive plate the demand is only poor. A very attractive display of Sheffield products has recently been held at one of the principal stores in the centre of the city, and as a result of it several valuable orders for cabinets of cutlery and services of plate have been booked by the firms exhibiting. In spite of the progress of stainless cutlery, ware of the older material is still preferred by some users. Among them is the White Star Company, which still furnishes the tables of its ships with knives of non-stainless steel. In a recent order for 200 dozen of table and dessert knives with ivory handles, the company specified that the blades should be hand forged of double-shear steel. More than half of this contract was secured by a local firm, and it is stated that the remainder went to Birmingham.

Barnsley Water Extensions.

Barnsley Corporation has decided to promote a parliamentary Bill for the purpose of obtaining power to construct an additional reservoir at Royd Moor. Increased supplies of water for the town are becoming urgently needed. At present there is a supply of 1,000,000 gallons per day from Ingbirchworth reservoir and 1,800,000 gallons from Midhope, while the completion of the Scout Dyke scheme will give a further 700,000 gallons. The chairman of the Water Committee pointed out that the requirements amounted to 3,300,000 gallons per day, so that they were rapidly approaching a demand that would equal the supply, even with the water to be received from Scout Dyke. The scheme now proposed will only meet the need up to the year 1930. The estimated cost is £362,000. On this basis, the water to be received from the reservoir will cost 1s. 2d. per 1000 gallons, and will be the town's most expensive supply. With regard to the future, the chairman said that the Committee felt that instead of bringing small schemes like the present one forward every few years, they should go into partnership with other places and produce a comprehensive scheme, but evidently the time was not yet ripe for that, and in any case Parliament would insist upon their making the most of their own resources before they went elsewhere.

Proposed South Yorkshire Ship Canal.

Some progress is reported in connection with the scheme for constructing a South Yorkshire ship canal from Doncaster to Trent Falls. The sub-committee which was appointed at the recent Doncaster conference recommends that expert advice should be sought on the question An engineer is to be selected to advise the Committee as to the best line to be pursued for the suggested waterway. He will also be asked to give his opinion as to the possibility of combining drainage and navigation, the probable cost of such a scheme, and to advise as to the steps to be taken for the salvage of coal lying beneath the beds of rivers, &c., as well as beneath the course of the new waterway.

A Large Sheffield Scheme.

Sheffield Corporation has on foot a scheme for the erection of a great double-deck tramway depôt and motor omnibus garage adjoining the present garage in the centre of the city. The building will embody the largest two-storey garage in existence. It will cost £100,000, and will cover 4515 square yards. In the course of the excavations, about 43,000 tons of earth will have to be removed.

Electricity Extension.

The York Corporation has received authority from the Electricity Commissioners to supply electricity to the parish of Aldwark, and to construct overhead mains.

NORTH OF ENGLAND.

(From our own Correspondent.)

No Christmas Holidays.

PROGRESS towards a normal state of industrial affairs is proceeding rapidly in the North of England. In the iron and steel trades a considerable proportion of idle plant has already been restarted, and it is expected that early in the New Year most firms will have their machinery busily employed. Producers of nearly all descriptions of material are being pressed for completion of deliveries that have been held up by the coal stoppage, and in their desire to meet the needs of customers, some firms are suggesting that the customary Christmas and New Year holidays should be dispensed with. The question of pay, however, is likely to prove a big obstacle, and up to the time of writing, no definite arrangement has been arrived at, though the suggestion is receiving the sympathetic consideration of the workers. It is felt that now that some of the rolling mills are in operation they should be kept working over the holidays. This would enable thousands of tons of material to be made, and permit of a start in the shipyards and with other constructional work early in the New Year. In accordance with the usual custom, the blast-furnaces will be kept in full operation.

Cleveland Iron Trade.

Resumption of activities in the pig iron trade, though still restricted by fuel scarcity, has been carried to a further stage on the North-East Coast than in any other producing area. With the lighting up this week of two blast-furnaces at Redcar, two at Skinningrove, and two at Normanby, there are now twenty-one blast-furnaces in operation on the North-East Coast, as compared with four at the end of the coal stoppage and thirty-eight before the coal stoppage. By the end of the year a substantial rate of production should be attained. An optimistic view is taken of business prospects. Under present circumstances, consumers are, of course, adopting a very cautious policy, but once there is a levelling of prices, it is generally felt that business will come forward in substantial volume. Inquiries on continental account are very few, but it is interesting to note that for the first time for many months a shipment was made this week to Antwerp. Prices at the moment are very uncertain. There is very little prompt foundry iron on offer, and for small parcels to cover consumers' urgent requirements, 110s. per ton has to be paid. There have been forward sales of No. 3 G.M.B. Cleveland pig iron at 85s. per ton, but they were based on hopes of cheaper fuel than is yet available, and consequently the forward quotation has now advanced to 87s. 6d. No. 1 Cleveland foundry iron is 90s.; No. 4 foundry, 86s. 6d.; and No. 4 forge, 85s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is unchanged. Prompt iron is almost unobtainable, but two or three more furnaces have been put into operation and forward business in mixed numbers is being done on the basis of 92s. 6d. per ton.

Ironmaking Materials.

There is now some prospect of foreign ore deliveries being resumed. Tonnage is still scarce, but a few boats are being offered, and a fixture from the Mediterranean to the Tees is reported this week at 9s. per ton, or about 2s. above the price before the coal stoppage. No new business in ore is yet reported, and deliveries under old contracts can only be resumed on a freight basis. The coke market is irregular. Makers' ideas of price vary considerably, but it is understood that contracts have been made for good Durham blast-furnace coke at 25s. per ton delivered at the works, which about represents the ironmasters' ideas of a fair market price.

Manufactured Iron and Steel.

Steel plant is being restored to activity at a rapid rate, and outputs in the North of England are already on a big scale. There is an enormous pressure for supplies, and some of the makers report that their order books are full for many months to come. Consumers are having to pay advanced prices to get delivery. Soft steel billets are quoted at £7 12s. 6d.; medium, £8 2s. 6d.; hard, £8 12s. 6d.; steel ship plates, £8 17s. 6d.; steel boiler plates, £12 10s.; steel joists and angles, £7 12s. 6d.; heavy steel rails, £8 10s.; common iron bars, £12 5s.; galvanised corrugated sheets, £17; and black sheets, £12 5s.

The Coal Trade.

Many difficulties have presented themselves in the efforts to resume normal operations in the Northern coalfield. A certain amount of progress has been made towards clearing the air to enable those engaged in the export trade to formulate their ideas as to future business. The embargo on exports has been entirely removed, and no more trouble will be experienced so far as formalties are concerned in the matter of making entries at the Customs, but the position throughout the market is very irregular, and varies with the situation at each individual colliery. In many instances mines are being laid idle or are on short time for want of wagons, and at other pits production is being dumped on the ground. There is also a marked scarcity of suitable coasting boats. Vessels got scattered far and wide during the national stoppage, and it will take some time for them to return to their customary trades. Some descriptions of coal are very heavily sold for this month, but in other cases supplies are abundant, and to secure prompt clearance, discounts can be obtained. On the whole, the main demand is for home requirements or under old contracts, but there has been a little more inquiry from abroad. Railway undertakings are preparing for their early requirements, and tenders have been submitted this week for the supply of 10,000 tons of Northumberland or Durham steam coals for the Norwegian State Railways. New business on the market matures very slowly, as buyers are not willing to commit themselves ahead, feeling confident that prices will slowly ebb. Hence there is a holding-off policy. Best Northumberland steams are well booked and hold steadily for 23s. for large and 13s. 6d. for smalls. Tyne prime and Wear special steams hold to 22s. to 24s. for large and 17s. 6d. to 20s. for smalls. Best Durham gas coal is about 24s., and secondary qualities 21s. 6d. to 22s. There is no development in the coke export trade. Buyers are holding off in anticipation of a substantial fall in values taking place in the near future. Foundry cokes are scarce, but production is slowly increasing. Makers hold to 35s. for good brands. Gas coke for export is quiet, and is quoted nominally at 40s. to 45s. A few inquiries are circulating, and, with a free export market, makers expect to secure additional business.

Bridge Contract.

It is announced that Dorman, Long and Co., Ltd., Middlesbrough, who have a number of important bridge contracts in hand, including the Sydney Harbour Bridge and the Newcastle-upon-Tyne Bridge, have secured the contract for the construction of a bridge over the Atbara in the Sudan.

SCOTLAND.

(From our own Correspondent.)

Slow Improvement.

BUSINESS in the steel, iron and coal trades improves slowly, more especially in the first two, for producers are going warily in view of present costs of production and probable reductions in the near future. Arrangements are being pushed forward, however, and in all probability most works will be fairly well occupied soon after the turn of the year. Markets, on the whole are therefore quietly awaiting developments.

Pig Iron.

Three or four furnaces in Ayrshire have been relit, and preparations are in progress for relighting furnaces at Gartsherrie. Others will be relit at the beginning of the year. The demand is increasing slowly, possibly because of the small supplies available at present and the high cost of small lots, but inquiries indicate a considerable increase in turnover when fair supplies are again possible. In the meantime the price for delivery remains in the region of 105s. for No. 1 foundry and 95s. per ton for No. 3 foundry for delivery when works resume production.

Steel and Iron.

At a meeting of the Scottish steel makers this week it was agreed to resume partial operations at some of the works at an early date. The position is dominated by the price of coal, which is still too high to permit of free operations on a large scale. Stewarts and Lloyds' works at Mossend have now six furnaces in operation and the mills are engaged producing material necessary chiefly for the company's tube works. Steel makers generally are not securing much fresh business, but already have sufficient orders on hand to ensure active employment for several months. Minimum prices for ship-plates and sections are unchanged, but it is said that makers are securing rather more for any business done in the meantime. Steel sheet makers are busy in practically all gauges, and have considerable arrears of orders to work off as circumstances allow. Prices, however, show some sign of relaxing a shade from the high levels touched during the strike. Bar iron works are again in operation, although not yet at full capacity. Makers are still chiefly concerned in the output of steel bars from continental material.

Coal.

There has been little real change in the position of the coal trade since last week. The demand for fuel for industrial purposes is comparatively weak, and this fact is reflected in the price of certain qualities of small stuffs, which are weakening almost daily. For inland sale screened steam is quoted 25s. to 27s. 6d.; unscreened steam, 20s. to 21s.; treble nuts, 27s. 6d. to 28s. 6d.; doubles, 26s. 6d.; singles, 20s. to 21s.; pearls, 15s. to 17s. 6d.; and dross, 16s. to 18s. 6d., all per ton f.o.t. at pit. Household coal is quoted between 25s. to 35s. per ton, according to quality, but top brands remain in the region of 40s. per ton. The export department is slow. Foreign buyers are not prepared to pay the current rates for prompt shipment. Prices are fairly steady, being influenced by the state of the order books. Many collieries have orders to fulfil against contract, and those with a few orders booked some days ago help to steady prices. Screened steam is quoted 22s.; unscreened, 20s.; treble nuts, 25s.; doubles, 23s. 6d.; singles, 22s.; pearls, 20s.; and dross, 15s., all per ton f.o.b. Forth ports. Aggregate shipments for the past week amounted to 132,873 tons, against 127,596 in the preceding week, and 290,375 tons in the corresponding week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Position.

THE conditions in the coal export trade are improving, but it will be a little time before the stage of transition from importing to exporting on a full scale is accomplished. There is still coal coming in from abroad, but it is on a diminishing basis. From all accounts many cargoes of coal, more especially from America, have been cancelled, and every attention is now being given to finding business for Welsh coals. The inquiry from abroad is expanding, but at the same time actual buying is on a moderate scale, as most foreign consumers are postponing operating until prices come down to a more reasonable basis. Still, last week steamers were chartered to load over 300,000 tons of Welsh coals, and there is a fair amount of tonnage offering. One of the surprises has been the comparatively heavy quantity of tonnage which has become available immediately the export of coals from this district is resumed. The supply of tonnage has more than kept pace with the orders on the market, as is shown by the fact that whereas the rate of freight for West Italy opened at between 12s. 6d. to 13s. 6d., the position now is that tonnage can be secured at rates from 9s. 6d. to 10s. 6d., according to the size of the steamers. Rates for other near Mediterranean destinations have declined on about the same scale. There is every evidence that after the initial rush for cargoes the demand is quieter, but at the same time the feeling prevails that the New Year will see much more business on the market, and that there will be an all-round improvement in the export of coals. At the present time slightly more than half of the loading tips at the South Wales ports are occupied, but a steady increase in the arrivals of tonnage is looked for from now on. One satisfactory feature is the fact that all restrictions on exports which were imposed by the authorities have now been removed. The last to go was that on the exportation of anthracite coal and coke. This was taken off as from midnight on Sunday last.

Coalfield Agreement.

The new coalfield agreement for this district was signed at Cardiff on Monday, and is for a period of three years. It is over eleven years since an agreement was concluded by the local Conciliation Board independently of a national agreement. This new agreement comes to an end automatically on December 31st, 1929, and therefore in that respect it differs from previous agreements, which were made for a particular period, subject to notice to terminate from either side. The onus of having to give notice will not now fall upon either party. Under the agreement the joint standing disputes committee is retained, so that the machinery is maintained by which disputes and difficulties can be dealt with. The 42·22 per cent. and the present subsistence wage are to be continued to May 31st, and the agreement provides for an eight-hour shift on five days of the week and seven hours on the morning shift on the Saturday. Every effort is to be made to expedite the reopening of workings, so that employment shall be given as far as possible to the men employed prior to the coal stoppage.

Expediting Shipments.

In times past many complaints have been made, more especially by shipowners, with respect to the delays encountered in the loading of steamers at South Wales ports. The matter has not been ignored by those who are interested in securing the maximum amount of business for this district; on the contrary, the subject has been seriously discussed, and at last an agreement has been arrived at which, it is hoped, will lead to a speeding up in shipments. The South Wales coalowners, after negotiations with the Coal Exporters' Association, have agreed to a revised scale of loading hours, which provides six hours per 100 tons for the first 1000 tons; four hours per 100 tons for the next 1000 to 2000 tons; and 2½ hours per 100 tons afterwards, no steamer's loading time to be less than sixty hours. The scale therefore works out at 60 hours for a steamer of 1000 tons; 125 hours for a steamer of 3000 tons; 200 hours for a steamer of 6000 tons, and so on. The present scale of loading hours is 60, 160 and 280 hours respectively for the sized steamers mentioned. The new arrangement comes into force when the new working hours for the trimmers and tippers operate. Up to the moment definite agreement has not been completed with the trimmers, but hopes are entertained that it will not be long before the workmen fall into line.

Miners' Movement.

The breakaway from the South Wales Miners' Federation on the part of a section of the workmen in the coalfield appears to be spreading, and meeting with more support than was at first expected. This new organisation is known as the South Wales Miners' Industrial Union, and is to be strictly non-political. Lieut. W. J. Batterbee, of Bargoed, has been appointed solicitor to the union, and Bargoed is likely to be its headquarters. The movement displays considerable activity in the Rhymney Valley, and it is stated that before very long the union will have a membership of 15,000 to 20,000.

Works Re-starting.

The resumption of work in the coalfield is having a beneficial effect upon allied industries. Work was resumed on Monday in the rolling department of Messrs. Guest, Keen and Nettlefold's iron and steel works at Dowlais, after a stoppage of about eight months, while the same company's Dowlais Works at Cardiff re-started on Tuesday, about 800 men commencing work immediately, while the remainder of the workmen will be taken on as soon as coke is available to re-light the blast-furnaces. In the Llanelly district several of the tin-plate works were to make a re-start this week, and additional furnaces were to be put into commission at the Llanelly Steel Company's works, thus bringing the total in operation to six.

The Market.

Business has been fairly active in steam coals during the past week for early loading, and the tone of the market is about steady for immediate supplies, but is easier for forward loading. Outputs have not yet reached anything like the normal, but in the course of a few weeks it is expected that the production will be very much heavier, and as lower values are looked for buyers are holding off. Best Admiralty large coals are about 32s. to 33s., with ordinary large and Monmouthshire descriptions ranging from 28s. 6d. to 30s. Smalls are quoted at about 24s. for the best, with cargo qualities ruling from 16s. 6d. to 20s. Supplies of patent fuel are scarce, as some of the works are only now resuming operations, and prices quoted range from 35s. to 40s. Coke is extremely scarce, and pitwood commands from 50s. to 52s. 6d. The French Navy is in the market for 24,000 tons of Admiralty large coal for delivery over the first half of 1927, while tenders have to be in at Cairo on the 18th inst. for 160,000 metric tons of large steam coals for the Egyptian State Railways.

Tin-plate Works Acquisition.

The official announcement is made that the Bynea Steel Company, Ltd., has purchased the St. David's Tin-plate Works, Loughor. The latter have been completely idle since May last, and for a month or more have been in the hands of a receiver. The works comprise ten mills, providing work in normal times for about 500 men. The new owners purpose resuming operations at these works early in the new year.

John C. Phillips.

The death of Mr. John C. Phillips is announced as having taken place on Wednesday, December 8th, at Stow Park-avenue, Newport, Mon. Mr. Phillips was a director and departmental manager of the firm of Charles D. Phillips, Ltd., Newport, Mon. He was the fourth son of the late Mr. Charles D. Phillips, J.P., and was born on October 20th, 1879. He was educated at Christ's College, Brecon, and at Brighton House School, Bristol. Mr. Phillips was a familiar figure at most of the chief agricultural shows. He was keenly interested in agriculture, and for some years farmed Church Farm, Marshfield, the tenancy of which has been in the Phillips's family for some generations. He leaves a wide circle of friends, to whom his death will come as a great shock. He served during the war in the Honourable Artillery Company.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that, as from Christmas next, Mr. John Milburn has resigned his position of works director of Alfred Herbert, Ltd., of Coventry.

WELDRICS (1922), Ltd., of Kingston-road, Raynes Park, London, S.W. 20, asks us to announce that on and after January 1st, 1927, its address will be Station-road, Beeston, Notts. Telephone, 245 Beeston; telegrams, "Weldrines, Beeston, Notts.

MARSHALL, SONS AND CO., Ltd., of Gainsborough, Lincs., inform us that they have just heard that at the Presidency Agricultural Show, Poona, India, in October last, they were awarded for their exhibits two gold medals and three bronze medals, one of the gold medals being given for the "Marshall" all-steel frame thrashing machinery.

WE are asked to announce that Leyland Motors, Ltd., has disposed of the steam wagon portion of its business to Atkinson Walker Wagons, Ltd., of Preston. The latter company has taken over all existing stocks of components and units, and it is requested that all inquiries for spare parts, replacements and overhauls for Leyland steam wagons should in future be addressed to the Atkinson Walker company at its offices, Frenchwood Works, Preston.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	18/- to 21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	—	—
No. 1 Foundry	‡4 17 6 to 5 0 0	—
No. 3 Foundry	‡4 12 6 to 4 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	(c) 4 10 0	4 10 0
No. 1	(c) 4 11 0	4 11 0
Cleveland—		
No. 1	(c) 4 7 6	4 7 6
Silicious Iron	(c) 4 7 6	4 7 6
No. 3 G.M.B.	(c) 4 5 0	4 5 0
No. 4 Foundry	(c) 4 4 0	4 4 0
No. 4 Forge	(c) 4 3 0	4 3 0
Mottled	(c) 4 2 0	4 2 0
White	(c) 4 2 0	4 2 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
" " Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	4 5 0	—
" Forge	—	—
(3) Derbyshire—		
No. 3 Foundry	4 5 0	—
Forge	—	—
(3) Lincolnshire—		
No. 3 Foundry	4 5 0	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (a); 4 18 6 (b); 5 2 0 (c)	—

‡ *For delivery after resumption of work at furnaces.*

(c) *January - February Delivery.*

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	11 15 0
Best	—	—
N.E. COAST—		
Common Bars	12 5 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 5 0 to 11 10 0	
Gas Tube Strip	15 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up	(d) 8 2 6	7 0 0
Sections	7 17 6 to 8 0 0	6 5 0
Steel Sheets, under 3/16in. to ¼in.	12 0 0 to 13 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	17 0 0

(d) *Official Minimum, actual prices about 5s. more.*

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 17 6	—
Angles	8 12 6	—
Boiler Plates	12 10 0	—
Joists	8 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0†	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 5 0	—
" (Small Round)	9 10 0	—
Hoops (Baling)	11 0 0	11 0 0
" (Soft Steel)	10 15 0	10 15 0
Plates	8 15 0 to 9 0 0	
" (Lancs. Boiler)	11 15 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	8 0 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 5 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 0 0 to 17 5 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	—	
Boiler Plates	—	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/9 to 22/6
Block Tin (cash)	308 5 0
" (three months)	299 10 0
Copper (cash)	57 2 6
" (three months)	57 17 6
Spanish Lead (cash)	29 3 9
" (three months)	29 10 0
Spelter (cash)	33 2 6
" (three months)	33 3 0
MANCHESTER—	
Copper, Best Selected Ingots	64 5 0
" Electrolytic	64 17 6
" Strong Sheets	92 0 0
" Tubes (Basis Price) lb.	0 1 1
Brass Tubes (Basis Price) lb.	0 1 0
" Condenser lb.	0 1 2½
Lead, English	30 17 6
" Foreign	29 10 0
Spelter	33 0 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
" " 6 p.c. to 8 p.c. "	£22 0 0	7/3
" " 8 p.c. to 10 p.c. "	£20 12 6	6/6
" " Specially Refined		
" "Max. 2 p.c. carbon	£36 0 0	12/6
" " " 1 p.c. "	£42 0 0	15/-
" " " 0·70 p.c. carbon	£54 0 0	17/6
" " " carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
" Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
" " 75 p.c.	£18 0 0 scale 6/- per unit	
" Vanadium	14/3 per lb.	
" Molybdenum	5/- per lb.	
" Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	8/3 per lb.	

FUELS.

SCOTLAND.

	(*Prices nominal.*) Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/9
" " Ell	16/6
" " Splint	16/6 to 17/-
" " Trebles	15/9
" " Doubles	14/- to 14/6
" " Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
" " Jewel	17/- to 17/6
" " Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

	Export.
(8) N.W. COAST—	
Steams	28/-
Household	*No quotation.*
Coke	33/-
NORTHUMBERLAND—	
Best Steams	23/6 to 27/-
Second Steams	21/- to 22/-
Steam Smalls	17/6
Unscreened	20/- to 22/-
Household	30/- to 36/-
DURHAM—	
Best Gas	23/-
Second	21/-
Household	30/- to 36/-
Foundry Coke	32/6 to 35/-

SHEFFIELD—	Inland. (*Nominal, none on offer.*)
Best Hand-picked Branch	31/- to 34/-
Barnsley Best Silkstone	28/- to 30/-
Derbyshire Best Brights	26/- to 28/-
" " House	24/- to 25/-
" " Large Nuts	17/- to 20/-
" " Small	12/6 to 14/-
Yorkshire Hards	17/- to 19/6
Derbyshire Hards	16/- to 19/-
Rough Slacks	10/- to 12/6
Nutty Slacks	7/6 to 9/-
Smalls	3/6 to 6/-
Blast-furnace Coke (Inland)*	—
" " (Export)	f.o.b. 16/- to 17/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	31/6 to 32/6
Second "	30/- to 31/6
Best Dry Large	30/- to 31/6
Ordinary Dry Large	28/6 to 29/-
Best Black Vein Large	28/- to 30/-
Western Valley Large	28/- to 29/-
Best Eastern Valley Large	28/6 to 29/6
Ordinary " "	27/6 to 28/6
Best Steam Smalls	22/6 to 24/-
Ordinary "	15/- to 20/-
Washed Nuts	30/- to 35/-
No. 3 Rhondda Large	35/- to 36/-
" " Smalls	25/- to 27/-
No. 2 " Large	30/- to 31/-
" " Through	25/- to 27/-
" " Smalls	20/- to 22/6
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	—
Patent Fuel	32/6 to 37,6
Pitwood (ex ship)	50/- to 52/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	47/6 to 50/-
Seconds	45/- to 47/6
Red Vein	39/- to 40/-
Machine-made Cobbles	55/- to 57/6
Nuts	57/6 to 60/-
Beans	50/- to 55/6
Peas	29/- to 30/-
Breaker Duff	12/- to 12/6
Rubbly Culm	16/- to 17/-
Steam Coals :	
Large	27/6 to 32/6
Seconds	25/- to 27/6
Smalls	15/- to 17/-
Cargo Through	21/6 to 24/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Outlook.

THE seriousness of the depression which has overtaken the manufacturing industries as a whole can no longer be questioned. The first thing that happened when the franc started upon its rapid upward movement was a stoppage of inquiries on export account, and that coincided with the termination of the miners' strike in Great Britain, which deprived the country of a customer whose temporary requirements were considerable. Then home consumers held aloof in the belief that prices must necessarily fall, that belief being encouraged by the wide-spread publicity which is given to every small decline in the prices of commodities. It is sought to prove that prices must adapt themselves to the new value of the franc, but, so far, they have not been modified to any appreciable extent, and consumers will not buy because they are convinced that they are perfectly safe in waiting. Now that orders are worked off, there is little to do, and the situation is regarded as serious. The depression is particularly marked in the motor car industry, as well as in all branches of trade dependent upon it, and, generally, shorter time is being worked everywhere, with fewer hands. At present there is very little likelihood of prices coming down. They are 50 per cent. higher than they were a year ago when the franc stood at much the same level as it does now, and if prices are to recede there must be some reduction in wages, which appears, for the moment, out of the question. Wages rose with the falling franc, and they do not decline with its appreciation. Nor can any relief be obtained from the higher taxation which weighs so heavily upon industry. From the point of view of steel makers, the situation has been saved by the operations of the Steel Cartel, which has reduced the production by a million and a-half tons. Lower prices cannot be taken because the situation is dominated by the high values of pig iron and coal, and, compared with the prices of a year ago, pig iron has advanced proportionately much more than the finished products. It seems fairly certain that a critical period of readjustment of supply and demand and wages will have to be gone through before there can be any improvement in the situation.

Public Works.

Meanwhile, the Government is credited with the intention of doing what it can to enable the country to tide over the threatened crisis by putting in hand its scheme of public works. The Bill, which is being drawn up for presentation to Parliament, provides for the execution of productive works, such as the Rhone hydraulic scheme and the carrying out of vast undertakings in the Colonies. A loan of 135 million francs is also to be raised to continue the work of reconstruction in the department of the Somme, while the Paris Municipal Council is considering the advisability of raising a loan of 400 million francs. Of that sum 61,500,000 francs will be devoted to the construction of incineration and other works for the destruction of household refuse, and the remainder will be utilised for the completion of the Metropolitan railway system. All this will, of course, provide some employment, but the engineering trades, as a whole, can hardly expect to experience a definite improvement until the situation becomes normal. Unfortunately the crisis, if it develops, is not likely to hasten the time when facilities will be offered for an expansion of foreign trade. Now that the franc has suddenly improved in value, and it is seen that prime costs are not declining in inverse ratio, it is feared that this market will be thrown open to foreign competition unless steps are immediately taken to protect home manufacturers. The Government is therefore being urged to introduce, without delay, the new Tariff Bill, which proposes a considerable increase in the import duties on foreign goods. Under it the duties are to be levied on the basis of gold francs, and goods are to be classified in such a way that, in nearly all cases, there will be an appreciable advance. So far foreign goods have been kept out of the country automatically by the exchange rate, and the French have been able to sell in other markets; but, as the conditions at present are not favourable to foreign trade, the only hope of an industrial activity lies in an interchange of goods, which the policy now advocated will render increasingly difficult.

The Steel Cartel.

Two meetings are to be held in Paris shortly, one of the Steel Cartel and other of the Rail Union, and both have to deal with problems of a delicate character. The Central European steel producers are to discuss with the Cartel the conditions of their admission into that body, and they have to fix upon the participation of Czecho-Slovakia, Austria and Hungary. The difficulty arises from the claims of Poland, which the other countries regard as excessive, especially in view of the fact that the Polish steel makers receive a bounty on each ton of steel exported. The Czecho-Slovakian and Austrian producers affirm that they will be shut out entirely from the foreign markets if the claims of the Polish steel makers are allowed. The object of the meeting of the Rail Union is to obtain the signature of Germany, which refuses to give its adhesion unless the quantities of rails that have to be supplied on account of reparation are excluded from the participation, and unless some allowance is made for the quantity of rails which, under the Geneva agreement, Germany has to purchase from Poland.

Electric Canal Haulage.

Amongst the systems of electric haulage which are giving satisfactory results on the canals in the North of France is the trolley motor controlled from the barge. There are other systems in use, and on one or two sections endless track vehicles are employed. The work of electrification was carried out by the State for a distance of 85 miles, and it was continued by the Office National de Navigation, which expects to complete, by the end of this year, the electrification of the canals between Saint-Omer and Joinville, a distance of 170 miles. The object is to accelerate the coal traffic between the northern collieries and Paris.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

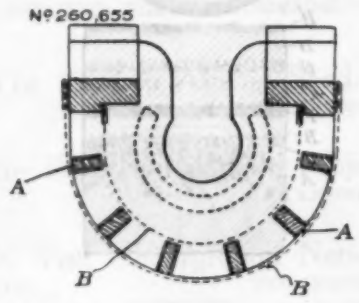
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

260,655. March 30th, 1925.—GAUGE GLASS PROTECTORS, Babcock and Wilcox, Ltd., Farringdon-street, London, E.C. 4; and S. F. Weston, Ellesmere, Lansdowne-road, Church End, Finchley, London, N. 3.

This protector is made of a series of vertical metal slats A A fixed in end frames attached to the gauge glass fittings. Two wire mesh screens B B are fixed to these slats and are arranged

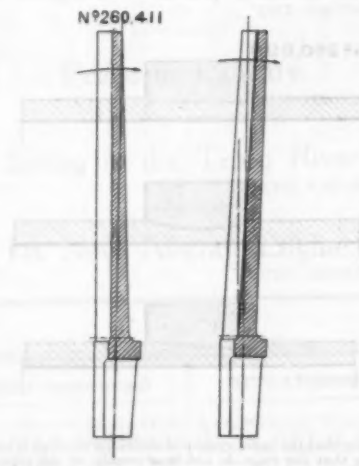


with "the diagonal lines of the mesh horizontal and vertical." This arrangement, it is said, affords a comparatively clear view of the gauge glass. Inspection of the gauge glass may be facilitated by the provision of semi-circular recesses on the rear edges of the slats, while specially large recesses may be formed at positions adjacent the normal and the extreme working limits.—*November 11th*, 1926.

TURBINE MACHINERY.

260,411. October 13th, 1925.—STEAM TURBINE BLADING, G. W. Higgs-Walker, Whitehall, Kingswinford, near Dudley, Staffs., and the Metropolitan-Vickers Company, 4, Central-buildings, Westminster.

In this specification it is suggested that the failure of steam turbine blades is caused by the concentration of stress at the thin edge of the blades, where incipient cracks may develop.

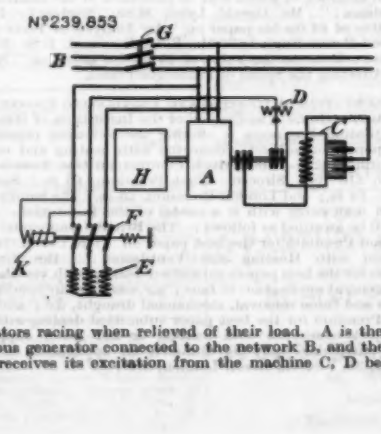


This concentration is produced by the setting of the blade with the working face radial—as shown on the left. It will be seen that centrifugal force tends to bend the blade forward, as also does the impact of the steam. By setting the blades with a forward rake—as shown on the right—the centrifugal force acts in opposition to the steam, and relieves the thin edge of the blade from stress.—*November 4th*, 1926.

DYNAMOS AND MOTORS.

239,853. September 7th, 1925.—IMPROVEMENTS IN OR RELATING TO THE GENERATING OF ELECTRICITY BY MEANS OF ASYNCHRONOUS GENERATORS, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

The object of this invention is to prevent asynchronous

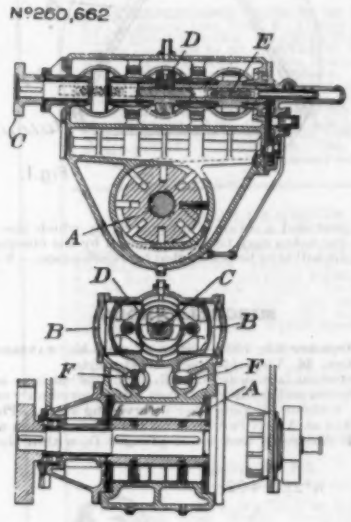


generators racing when relieved of their load. A is the asynchronous generator connected to the network B, and the generator receives its excitation from the machine C, D being an exciting transformer. A resistance E can be connected by a switch F to the machine A. If this machine is disconnected from the network by opening the switch G, the speed of the driving machine H increases. At the same time, however, the pressure at the machine A increases. The switch F is closed by the coil K, and the machine is connected to the artificial load E. The machine is therefore prevented from racing, and it is not put out of action by the usual protective devices.—*November 4th*, 1926.

TRANSMISSION OF POWER.

260,662. July 31st, 1925.—HYDRAULIC CHANGE SPEED GEAR, H. Lentz and Lentz Patents, Ltd., 4, Dean Stanley-street, Westminster.

In this gear the normal Lentz rotary motor A has been adopted, but the pumping part is of the reciprocating type. The pumping cylinders B B are arranged on either side of the driving shaft C and are operated by excentric sheaves D. The excen-

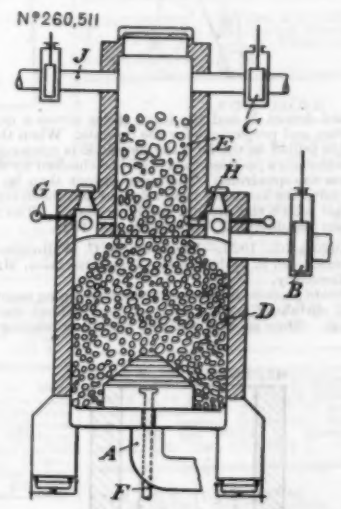


tricity of these sheaves can be varied by mechanism operated by the sliding spindle E. Rotary valves F F are provided to control the flow of the liquid to and from the pumps. By altering the throw of the excentrics the flow of liquid can be altered from maximum in one direction to maximum in the other, and the speed of the driven shaft is correspondingly varied.—*November 1st*, 1926.

GAS PRODUCERS.

260,511. May 27th, 1926.—PRODUCERS FOR CARBURETTED WATER GAS, Frankfurter Gasgesellschaft, 38, Obermainstrasse, Frankfort-on-Main, Germany; F. P. Tillmetz, 38, Obermainstrasse, Frankfort-on-Main; and E. Schumacher, 36, Obermainstrasse, Frankfort-on-Main.

This producer operates as follows:—First, air is blown in from below through the pipe A, the two dampers B and C being open to atmosphere. As soon as the temperature has reached a certain value the two dampers B C are so adjusted that a higher



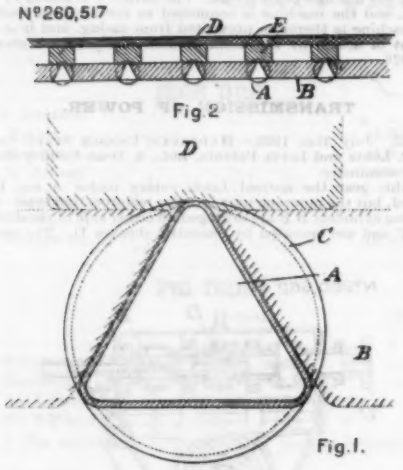
temperature up to about 1000 deg. Cent. is produced in the lower shaft D, while the temperature in the upper shaft E is maintained at about 700 deg. to 800 deg. The change-over is then made, and steam is introduced into the lower shaft from below through the pipe F, while oil vapour and steam are blown at the same time into the upper shaft through the pipes G and jets H. The dampers B and C being closed, the carburetted water gas formed passes through the outlet J to the point of utilisation.—*November 4th*, 1926

FURNACES.

260,517. June 18th, 1926.—WATER-COOLED FURNACE WALLS, Babcock and Wilcox, Ltd., Farringdon-street, London, E.C. 4, and C. H. Davy, 72, The Avenue, Beckenham, Kent.

As shown in Fig. 1 the wall is built up of water circulating tubes A connected at their upper and lower ends to headers and interposed rows of brickwork B. The circulating tubes A are triangular in section, and so disposed that one-third of the tube surface is exposed to radiant heat of the furnace. These tubes have ends of circular section C, capable of being expanded into or attached to the headers. The space between the opposite walls of adjacent tubes is filled with rows of brickwork, consisting of wedge-shape bricks, the wedge shape of the brick preventing it from falling into the furnace. Behind the rear angle

of each tube a row of bricks D is arranged, and assists in keeping the fire-bricks B in position. Between the usual outer casing E—Fig. 2—of the furnace and the fire-bricks B there is con-

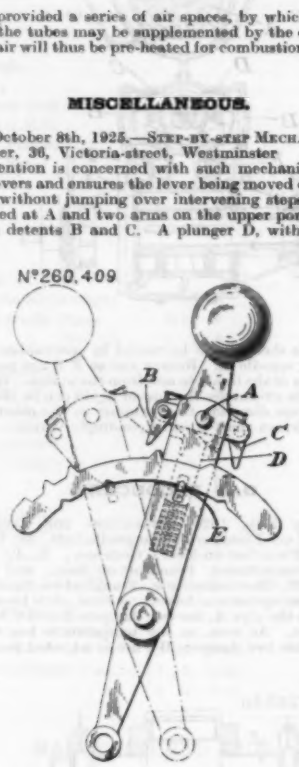


sequently provided a series of air spaces, by which the cooling caused by the tubes may be supplemented by the circulation of air, which air will thus be pre-heated for combustion.—*November 4th*, 1926.

MISCELLANEOUS.

260,409. October 8th, 1925.—STEP-BY-STEP MECHANISMS, S. R. Fletcher, 36, Victoria-street, Westminster.

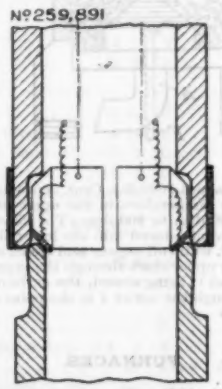
This invention is concerned with such mechanisms as gear-changing levers and ensures the lever being moved only one step at a time, without jumping over intervening steps. The lever is articulated at A and two arms on the upper portion are provided with detents B and C. A plunger D, within the lever,



works a third detent E and the lever slides across a quadrant having notches and projections for the detents. When the knob of the lever is pulled to the left, the detent E is released and B is brought into such a position that it will be checked by the next projection on the quadrant. The lever cannot then be moved any further until the knob has been released and the detent E re-engaged, after which the process can be repeated. The reverse action utilises the detent C.—*November 4th*, 1926.

259,891. August 7th, 1926.—PIPE JOINTS, C. Wallmann and J. Grosswelschede, 5, Ruhrstrasse, Neustadtstrasse, Mülheim-Ruhr, Germany.

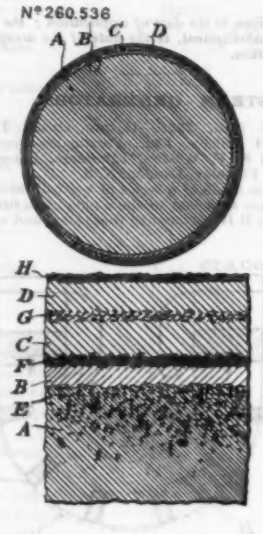
The inventors propose to connect lengths of piping together by a process of shrinking one on to the other without the use of external rings. They suggest that the necessary heating should



be effected electrically, as shown in the drawing, and that lagging should be used to prevent the loss of heat from the exterior of the pipe and its conduction to the cold piece of pipe. There are no less than thirty-two claims in the specification.—*October 21st*, 1926.

260,536. June 24th, 1925.—PROTECTION OF CUPROUS METALS AGAINST CORROSION, *George Beloe Ellis, of Mowburn, Ellis and Co., of* 70–72, *Chancery-lane, London, W.C. 2.*

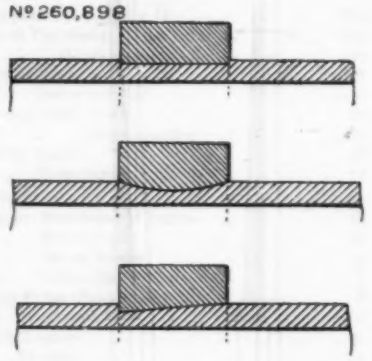
Referring to the illustration a copper rod A is coated by plating with iron B. A second coating of chromium C is plated on the iron and a third coating D of nickel is similarly applied. The article thus produced may be used as a finished product, and subjected to the high temperature involved in such use, in which case the conditions of use will fix the coatings by an oxidising and alloying effect. Alternatively, the article produced by the successive coatings may be heated before use. In this case, it is preferred to use an oxidising atmosphere, which will form an oxide coating, which contributes materially to the success of the process. A suitable method of heating is to expose the article to a temperature of 850 deg.



Cent. for four hours, and to a further temperature of 1000 deg. Cent. for another four hours. In this plating operation there is a diffusion of the metals into each other and a formation of layers of alloys and metals, as indicated in the lower drawing, where the copper base is indicated at A, a layer of copper iron alloy at E, a layer of iron at B, a layer of iron-chromium alloy at F, a layer of chromium at C, a layer of chromium-nickel alloy at G, and a layer of nickel at D. Outside the latter there is a thin film of extremely adherent nickel oxide H, which is very dense and non-porous.—*October 25th*, 1926.

260,898. June 11th, 1926.—PIPES WITH SHRUNK-ON HOOPING RINGS, Mannesmannröhren-Werke, Berger Ufer 1a, Düsseldorf, Germany.

This invention is presumably concerned with the penstocks of water turbines working under great heads, in which it is found advisable to employ a comparatively thin pipe reinforced occasionally by shrunk-on rings, on account of the difficulty of making a satisfactory weld in a plain pipe of sufficient thickness to withstand the internal pressure. It is suggested in the



specification that the usual system of shrinking on rings is unsatisfactory, in that the rings do not bear evenly on the pipe, they may be displaced accidentally in transport, and may be loosened by solar radiation. The rings are consequently, according to the invention, held in place by being shrunk into recesses in the periphery of the pipe, as shown in the drawings. It is to be assumed that the grooves and rings are machined to secure a good bedding, although it is not mentioned in the specification.—*November 11th*, 1926.

THE INSTITUTION OF MECHANICAL ENGINEERS.—The following awards have been made by the Council of the Institution of Mechanical Engineers for papers read before the Graduates' Sections of the Institution during the session 1925–26:—Mr. J. Price Walters, B.Sc. Tech. (Student): Prize to the value of £5 for his paper on "The Mechanical Equipment of Modern Electric Lifts," an abstract of which will be published in the Institution "Proceedings;" Mr. Gerald Lyon, M.Sc. (Student): Prize to the value of £4 for his paper on "An Analysis of Tests on a High-speed Petrol Engine;" Mr. F. C. Johansen, B.Sc (Eng.) (Graduate): Prize to the value of £3 for his paper on "Some Factors Affecting the Speed of Passenger Trains."

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS, PRIZE COMPETITION.—The Council of the Institution of Heating and Ventilating Engineers is offering the following prizes for original papers on subjects connected with heating and ventilating during 1927:—The British Commercial Gas Association Premium, £10 10s.; Sirocco: First Premium, £6 6s.; Second Premium, £4 4s.; and London Premium, £5 5s. The winning of an award may carry with it a medal of the Institution. The prizes will be awarded as follows:—The British Commercial Gas Association Premium for the best paper on "The Use of Gas in Connection with Heating and Ventilating;" the Sirocco Premiums for the best papers submitted dealing with ventilation and the general application of fans; air washing, air conditioning, dust and fume removal, mechanical draught, &c.; and the London Premium for the best paper submitted dealing with, or any subject connected with heating or hot water supplies. Further particulars may be obtained on application to the Secretary, 36, Victoria-street, London, S.W.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall, St. George's-square, Sheffield. "The Influence of Sulphur in Cast Iron," by Mr. J. E. Hurst. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Progress Methods Employed in a Large Mass Production Motor Works," by Mr. H. D. Glover. 7.30 p.m.

SATURDAY, DECEMBER 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—London Graduates visit to the works of Truman, Hanbury and Buxton, Ltd., Spitalfields, E. 1. 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the surveying instrument works of E. R. Watts and Son, Ltd., Camberwell.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Newcastle-upon-Tyne. Papers: "Thin Seam Mining," by Mr. T. S. Durham; and "The Chemical Relations of the Principal Varieties of Coal," by Professor G. Hickling. 2.30 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Graduates' visit to the Newcastle-upon-Tyne Electric Supply Company's Dunston Power Station. 2.30 p.m.

MONDAY, DECEMBER 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "Radiator Design," by Mr. F. Randle. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "Practical Wheel Balancing," by Mr. N. H. Stamp. 7 p.m.

TUESDAY, DECEMBER 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "A Comparison of Motor Cycle and Motor Car Design," by Mr. E. W. Coy. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—Engineering and Scientific Club, Queen-street, Wolverhampton. Paper, "Radiator Design," by Mr. F. Randle. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Paper, "High Elastic Limit Steel for Shipbuilding and Marine Work," by Mr. T. M. Service. 7.30 p.m.

WEDNESDAY, DECEMBER 22ND.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—London, S.E. 19. Award of certificates by Sir W. H. Ellis. 3 p.m.

FRIDAY, DECEMBER 31ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria street, London, S.W. 1. Questions and general technical and practical discussions. 7.30 p.m.

THE IMPERIAL COLLEGE OF SCIENCE.—The annual dinner of the Imperial College of Science and Technology was held at the Hotel Cecil on Monday, December 13th. Sir Thomas H. Holland (Rector of the Imperial College), who was accompanied by Lady Holland, presided over a large company. Sir Alfred Mond proposed "The Imperial College," and the chairman, in replying, said that the new system whereby the College's examinations and courses were adopted by London University, which had appointed appropriate external examiners, had necessarily brought it into direct touch with many questions affecting the University. He pointed out that the College had its own traditions and its own system of training, and had maintained its own standard for three-quarters of a century without the spur or control of university examinations. It had also its own Royal Charter and the college was founded for a definite purpose at a time when the Government at last realised the necessity of associating other industries with technical science. The governors, who represented the great technological institutions of London, were in obligation bound to see that the ideals of university life did not supersede those of Imperial necessity. Consistent with those primary responsibilities, it was their duty not only to add to the motive power of a great university machine, but to lubricate those parts of it that seemed to have been designed without regard to any known laws of administrative mechanics.

ROYAL INSTITUTION.—The following lecture arrangements at the Royal Institution before Easter next year were announced at the general meeting on Monday, December 6th. The Christmas course of six lectures for juveniles will be delivered by Professor A. V. Hill, on "Nerves and Muscles: How We Feel and Move," commencing on December 28th, at 3 p.m. On Tuesdays, at 5.15 p.m., beginning on January 18th, there will be two lectures by Professor R. Whytlaw-Gray on "Smokes as Aerial Disperse Systems;" six by Professor Julian Huxley, Fullerian Professor of Physiology, on "Problems of Animal Growth and Development;" two by Dr. G. Shearer on "X-rays and the Chemical Molecule;" and two by Professor J. W. Cobb on "Some Properties of Coke." On Thursday, January 20th, at the same hour, Mr. John B. H. Weaver will give the first of two lectures on "Romanesque and Early Pointed Architecture in Spain." They will be followed by three lectures on Thursday afternoons by Sir William Bragg on "Acoustical Problems Treated by Lord Rayleigh;" three by Professor John Garstang on "The Progress of Hittite Studies;" two by Mr. J. Guild on "Colour Measurement and Standardisation;" and two by Mr. Harold J. E. Peake on "The Beginnings and Early Spread of Agriculture." On Saturday afternoons at three o'clock, Professor E. W. Tristram will give two lectures on "English Mediæval Wall Painting," commencing on January 22nd. On succeeding Saturday afternoons there will be three lectures by Mr Walter de la Mare on (1) "Craftsmanship in Verse," (2) "'Atmosphere' in Fiction," (3) "The Supernatural in Fiction;" three with musical illustrations by Dr. McEwen on "Beethoven;" and four by Sir Ernest Rutherford on "The Alpha Rays and their Application to Atomic Structure." The Friday evening meetings will begin on January 21st, when Sir William Bragg will deliver a discourse on "Tyndall's Experiments on Magne-crystallic Action." Succeeding discourses will probably be given by Professor E. P. Cathcart, Captain T. L. Eckersley, Dr. Ernest Law, Sir Josiah Stamp, Professor D'Arcy Thompson, Sir Herbert Jackson, Dr. George Macdonald, Professor E. Hatschek, Professor C. T. R. Wilson, Sir Ernest Rutherford, and others.